

Regulating Robots by Owning Them

*A Retained Property Interest as a Graduated Quantity Instrument for
Labour-Market Adjustment, an Enforcement Route for Modification Control, and a
Civil Reserve Funded by Private Consumption*

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6 August 2026 · Version 1.1, revised October 2026

Suggested citation. Christopher I. V. Farmer, ‘Regulating Robots by Owning Them’ (2026) preprint, version 1.1
<https://doi.org/10.5281/zenodo.23462134>.

Status. Preprint; not yet peer reviewed.

DOI. <https://doi.org/10.5281/zenodo.23462134>

Keywords. robotics regulation; automation and labour markets; robot tax; EU Machinery Regulation; product liability; airworthiness; quantity regulation; property law

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Abstract

Two problems are approaching, they are usually treated as unrelated, and the instruments proposed for each are incapable of solving the other.

The first is displacement. Robotic systems capable of substituting for human labour across a widening range of tasks are being produced at falling cost. The policy debate about what to do has been almost entirely fiscal: tax the substitution, subsidise the retraining, redistribute the gain. The canonical proposal asks whether robots should pay something equivalent to payroll tax, and the literature that has grown around it argues about rates, bases and incidence.

The second is modification. A robotic system in private hands can be altered—in its hardware, in the software it runs, or in the constraints imposed on either—and a system altered outside its design envelope is dangerous in ways its manufacturer did not contemplate and its owner may not understand. The instrument approaching here is the European Union’s Machinery Regulation, which applies from 20 January 2027 and, for the first time, addresses tampering directly: machinery must be designed so that connecting another device does not create a hazard, and control systems and software must be secured against unauthorised modification.

Neither instrument can solve the other’s problem, and the reasons are structural rather than remediable.

A tax is a price instrument. It changes what substitution costs and does not control how much of it occurs, so a firm that can absorb the charge proceeds unaffected. It also confers no right of access: taxing a thing gives the state no entitlement to look inside it, which is why no fiscal proposal has ever been offered as an answer to the modification problem.

The Machinery Regulation is a market-entry instrument. Its obligations attach to the manufacturer at the moment of placing the product on the market, and they are discharged once. They say nothing about the unit in a citizen’s possession three years later running modified firmware. Layered with the Artificial Intelligence Act and the revised Product Liability Directive, the compliance burden on manufacturers is now substantial and it is all front-loaded. **Every instrument in the field attaches at the point of sale, and none survives into the operating life.**

This paper proposes a single structural change that addresses both. Citizens may possess robotic systems; the state retains the property. Possession passes under a lease; title does not.

A third capability follows from the same structure, is more consequential than either, and is the reason the paper has to deal with targeting law (Part V §20D). Because title never passes, a state facing armed attack, disaster or epidemic may recall units as the exercise of a reserved right in its own chattel rather than as an expropriation of anyone’s property. Expropriation asks whether the state may take what is yours; recall asks whether it may have back what is its own, and the second is a question about the construction of an agreement rather than a hard question answered slowly. The effect is a **latent reserve funded by private consumption**: a state that subsidises the machines, buys them as a monopsony, and retains their residual value obtains at a fraction of procurement cost a capability its possessors purchase and house. The precedents are old and unexotic—the Civil Reserve Air Fleet has committed privately owned airliners to military airlift since 1951, and forty-five merchant ships were taken up from trade for the Falklands in 1982.

That is a defence argument and this paper makes it in terms rather than leaving it to be inferred, because stating it is what exposes the objection that nearly defeats it. Military objectives include objects which by their **purpose**—meaning intended future use—make an effective contribution to military action. A statute reserving every unit of a designated class for defence tasks in an emergency is a standing statement of intended future use over every unit in the class. On that reading the scheme would confer a military purpose on several million domestic machines, and on the dwellings containing them, before any emergency and without anyone doing anything. The paper’s answer is a drafting discipline rather than a denial: the permitted tasks are listed exhaustively and confined to civil-protection functions; munitions carriage, military engineering and any use of a weapon are excluded expressly; recalled units must be delivered away from dwellings before use; and a state wanting the excluded capability must obtain it through a separate designated class that may not be kept at a dwelling. **What cannot be drafted away is that a belligerent will still make the argument**, and the honest conclusion is that a state unwilling to accept that should adopt the scheme without the recall limb, keeping the quantity and inspection capabilities and forgoing the third. Care and assistance units are absolutely exempt throughout, since their removal would create the emergency the recall claimed to answer.

That does two things no other instrument does together. It makes the **number of units in circulation a regulated quantity**, because a lease may be granted or refused—a labour-market instrument operating on volume rather than on price, and therefore capable of what a tax structurally cannot do. And it preserves a **continuing right of access**, because inspection is an ordinary incident of a lessor’s interest and requires no new regulatory theory to justify. That is what makes any rule against dangerous modification enforceable rather than aspirational.

The quantity is graduated, and the graduation is the design. Below a household entitlement, possession is as of right and nothing is rationed. Above it and below an industrial threshold, possession follows an application which states use, place and number and which is designed to be granted rather than refused—so that the tier restricts almost nothing and discloses a great deal. Only at industrial scale does

the number bind, and there it is set by reference to identified occupational classes and may be differentiated by sector, region and applicant. Three things follow. The restriction falls where the gain from substitution is captured, so ordinary households are not rationed at all—which a robot tax, falling on the retired person’s single unit and the logistics operator’s six hundredth alike, cannot manage. **The middle tier generates the deployment data from which the binding tier is calibrated**, which no fiscal instrument can do, because a tax return records a completed transaction in money while an application states an intention in units, uses and places. And the differentiation is enforceable, because a licence conditioned on use and place is verifiable on the same inspection the modification problem already requires, where a differentiated tax must take the taxpayer’s word for the category claimed. The structure is not invented: British goods-vehicle licensing exempts private use, caps the number of vehicles and ties them to a stated operating centre, under a regime that originated in the Transport Act 1968 and has run continuously since 1970.

Three consequences for the population are developed at Part V §20B and they are the reason the instrument is politically available at all. The regulated good becomes **cheaper**, because a lessor retaining the reversion can price below outright sale without loss and a single national channel buys as a monopsony — an unusual combination, since technology regulation ordinarily raises prices and redistribution ordinarily runs through the fiscal system at one remove from the thing distributed. **Access can be widened deliberately**: the lease term can be lengthened for those who cannot meet a capital outlay, the outright price discounted by identified category, and the free servicing obligation is flat in cash terms and steeply progressive in practice. No fiscal instrument has any of those levers, because a charge reaches the machine and not the person. And **timing decides whether the arrangement is a norm or an imposition**: legislated before an installed base exists it is a condition of acquisition, legislated afterwards it is the confiscation of an expectation — and coverage, on which all three capabilities depend, is a function of how early the rule attaches and of nothing else.

On what a reserve of numbers actually buys, the paper argues from the record rather than from imagination. Rescue robots were deployed at the World Trade Center site within six hours, in the first known use of robots for urban search and rescue; four teams took part. Forty thousand people worked that site, the recovery ran eight and a half months, and more than ninety thousand were exposed to its hazards. **The constraint in 2001 was never the concept but the number of machines four teams could carry to Manhattan**, because no mechanism existed by which a state could call on machines it did not own. The claim is disciplined in both directions: a domestic machine is not a void-penetration robot and no quantity substitutes for one — but the void search is not where eight and a half months went, and every hour a machine spends on such a site is an hour a person does not.

The precedent is not novel and that is the argument’s strength. Aviation airworthiness already does exactly this: private ownership, a continuing certificate, mandatory periodic inspection, and compulsory compliance with directives issued long after sale. The paper works that analogy in detail, because it is the one existing system that combines private possession with continuing state access and a functioning inspectorate.

The objections are taken at full strength, and the hardest is not the economic one. A right of access sufficient to inspect is a right of access sufficient to surveil, so the instrument that solves the modification problem creates a monitoring infrastructure reaching into private homes. The paper answers structurally rather than by assurance: inspection scope defined by statute and limited to the integrity of the unit and the provenance of its code, audit against a published attestation rather than data extraction, and the inspection right vested in an independent body rather than the executive.

The instrument is drafted at European Union level, and Part VIII tests it against international trade law, the United Kingdom, the United States and Asia. That Part reaches an uncomfortable conclusion which is stated plainly: **a retained-interest scheme is easiest for states with weak property protections to implement and hardest for those with strong ones**, and if the objection cannot be met the honest conclusion is that the instrument is regional rather than general.

Keywords: robotics regulation; automation and labour markets; robot tax; EU Machinery Regulation; product liability; airworthiness; quantity regulation; property law

Note on sources and method

Every authority has been checked against a primary or authoritative record before citation, and where a primary text could be read only through a secondary source the footnote says so. Anything unverifiable has been removed rather than approximated.

Three cautions.

The economic claims are directional, not quantified. This paper argues that a price instrument cannot control quantity and that a property instrument can. It does not model the effect of either on employment, wages or output, and where it states a magnitude it is taken from a cited source and marked. A reader looking for an estimate of how many units a licensing regime should permit will not find one here, and Part III explains why that number is a political judgement rather than a derivable one.

The proposal is an argument about what the law should be. Where the paper states what the law is—the Machinery Regulation’s obligations, the airworthiness regime’s structure, the protection of possessions under the Convention—that is checkable and is cited. Where it argues for a change, that is contestable and is marked as argument.

And the paper is proposing a substantial extension of state power over private property. That should be uncomfortable and the discomfort is not managed away. Part VII takes the objections at their strongest, and the surveillance objection in particular is treated as the one most likely to defeat the scheme rather than as one to be disposed of.

Part I—Introduction

1. Two problems and a shared blind spot

This paper concerns two problems which are approaching at the same time, are usually treated as unrelated, and turn out to share a structural feature that the instruments proposed for each cannot address.

Displacement. Robotic systems capable of substituting for human labour are being produced at falling cost and rising capability. What follows for employment, wages and the distribution of gains is contested, and this paper takes no position on the magnitude. What it observes is the shape of the policy response: it has been almost entirely fiscal. The canonical legal treatment asks whether robots should pay something equivalent to payroll tax, or whether firms installing them should face a special charge, and the literature that has grown around it argues about rates, bases and incidence.¹

Modification. A robotic system in private hands can be altered—its hardware, the software it runs, or the constraints imposed on either. A system altered outside its design envelope is dangerous in ways its manufacturer did not contemplate and its possessor may not understand. The instrument approaching here is the European Union’s Machinery Regulation, which applies from 20 January 2027 and addresses tampering directly for the first time.²

The shared blind spot is temporal, and the observation from which everything else in this paper follows.

Every instrument in the field attaches at a moment and is discharged there. A tax attaches at acquisition or at the point of use and is paid. A market-entry regulation attaches when the product is placed on the market and is satisfied by the design and documentation as they then stand. Neither reaches the unit in somebody’s possession three years later, and the modification problem is by definition a problem that arises later.

¹Ryan Abbott and Bret Bogenschneider, ‘Should Robots Pay Taxes? Tax Policy in the Age of Automation’ (2018) 12 *Harvard Law & Policy Review* 145.

²Regulation (EU) 2023/1230 of the European Parliament and of the Council of 14 June 2023 on machinery [2023] OJ L165/1, applying from 20 January 2027 (art 54, as corrected by Corrigendum [2023] OJ L169/35) and repealing Directive 2006/42/EC.

2. Why neither instrument can solve the other’s problem

The claim is not that the proposed instruments are badly designed. It is that each is structurally incapable of the other’s task, and the incapacity is not remediable by better drafting.

A tax cannot control quantity. That is what distinguishes a price instrument from a quantity instrument, and it is elementary: a charge alters the cost of an activity and leaves the decision with whoever bears the cost. A firm for which automation is worth more than the tax automates. If the policy objective is to influence the *rate* at which substitution occurs—which is what a concern about labour-market adjustment is a concern about—a price instrument delivers it only at a rate nobody chose, and only by guessing at an elasticity nobody knows.

A tax also confers no access. Taxing a thing gives the state no entitlement to examine it. That is so obvious that it is never stated, and the reason no fiscal proposal has ever been offered as an answer to the modification problem. The two literatures do not speak to each other because neither has anything the other needs.

And market-entry regulation cannot reach the operating life. The Machinery Regulation’s tampering provisions are obligations on the manufacturer, discharged by design and documentation at placing on the market.³ They are good obligations and this paper does not criticise them. They are simply obligations of a kind that is complete before the risk they address has arisen.

3. The proposal, stated at once

Citizens may possess robotic systems. The state retains the property. Possession passes under a lease; title does not.

Two consequences follow, and they are the whole of the argument.

The number of units in circulation becomes a regulated quantity, because a lease is granted or refused. That is a quantity instrument, it operates on volume rather than on price, and it is therefore capable of doing what a tax structurally cannot.

And the state retains a continuing right of access, because a right to inspect the thing let is an ordinary incident of a lessor’s interest. No new regulatory theory is required to justify it; the entitlement follows from the property relationship rather than being imposed alongside it. That is what makes a rule against dangerous modification enforceable rather than aspirational, and it is available for the whole of the unit’s operating life rather than at a single moment.

The precedent exists and is working. Aviation airworthiness combines private ownership with a continuing certificate, mandatory periodic inspection, and compulsory compliance with directives issued long after sale—the same combination of private possession, continuing state access, and post-sale modification control that this paper proposes. Part VI works the analogy in detail, including where it breaks.

4. What is new here, and what is not

4.1 What is not new

That automation raises distributive questions requiring a policy response is the subject of a large literature and is assumed rather than argued here.

That a robot tax has been proposed, and criticised is established. The canonical proposal is Abbott and Bogenschneider’s, and the case against has been put by others.⁴ This paper’s disagreement with the fiscal approach is about what a price instrument can structurally achieve, not about whether the particular proposals are well designed.

³ibid, and see Part IV.

⁴Abbott and Bogenschneider (n 1); and for the case against, Robert D Atkinson, *The Case Against Taxing Robots* (Information Technology and Innovation Foundation, 8 April 2019) <https://itif.org/publications/2019/04/08/case-against-taxing-robots/> accessed 16 October 2026.

That the Machinery Regulation addresses tampering is the content of the instrument.⁵

That the state may retain interests in privately possessed property is ordinary and unremarkable, and vehicle registration, firearms certification, spectrum licensing and airworthiness are all examples. Part VI treats the last as the closest analogue.

And that leasing rather than sale is a familiar commercial structure requires no support.

4.2 What is offered as new

First, the joining. Displacement and modification are treated as separate problems requiring separate instruments. The claim here is that they share a structural feature—both require something that persists into the operating life—and that a single change in the property relationship addresses both. So far as the author can establish, no proposal has been made which addresses them together, and the reason appears to be that the two literatures have no occasion to meet.

Second, the diagnosis that the field’s instruments are all point-in-time (Part I §1 and Parts III–IV), and the sharpest illustration of it. Annex III of the Machinery Regulation requires a machine to collect evidence of legitimate and illegitimate interventions in its software (point 1.1.9) and to keep a tracing log of them enabled for five years (point 1.2.1(f))—the Union has mandated that the evidence of modification be created and has opened it only to a conformity request made through the economic operators who placed the unit on the market. Stated generally: tax attaches and is paid, market-entry regulation attaches and is satisfied, and the risk they are asked to manage is continuing. Naming that as the common defect is offered as new.

Second A, the observation that the technical predicate already exists. The conformity assessment documents the approved configuration and point 1.1.9 requires the machine to collect evidence of interventions in its software and configuration, so the reference and the evidence are both in place. What is missing is a party entitled to compare them, which is what Part V supplies.

Second B, requisition without expropriation (Part V §20A and §20C). That a retained interest converts emergency requisition from a taking into the exercise of a reserved right, so that private consumption expenditure becomes a latent contingency reserve whose only standing public cost is the servicing that doubles as inspection — and that where the state also subsidises supply, buys as a monopsony and keeps the residual, it obtains at a fraction of procurement cost a capability that possessors buy and house. §20C states the defence character of this plainly rather than leaving it implicit, prices it against the alternative of direct procurement, and bounds it: converted civil machines are a sustainment capability of very large scale and not a combat capability, for engineering reasons before legal ones.

Second B(i), the targeting consequence, which is offered as the paper’s single most important finding (Part V §20D). “Purpose” in the definition of a military objective means intended future use. A statute reserving every unit of a designated class for defence tasks is therefore a standing statement of intended future use over every unit in the class, and on the ordinary reading confers a military purpose on the units — and raises a question about the dwellings containing them — before any emergency and without any act by anyone. So far as the author can establish **nobody has applied the definition of a military objective to a standing statutory reservation over privately possessed chattels**, and the omission matters because the contractual civil-reserve arrangements on which this paper draws happen to keep the reserved objects at airports and ports rather than in houses. A general requisition power is not confined in that way — Switzerland’s Military Act obliges every person, when the army is called up for active service, to make movable and immovable property available to the military administration and the army⁶ — but it attaches to everything of a kind and in the abstract, where the reservation proposed here is a term of the agreement under which each unit of a designated class is held. The paper’s response is a drafting discipline, set out at §20D.3 and carried into Articles 7A and 7C, and §20D.4 concedes that it mitigates rather than answers.

⁵Machinery Regulation (n 2).

⁶Federal Act of 3 February 1995 on the Armed Forces and the Military Administration (Militärgesetz, MG; SR 510.10), art 80(1)(a), as amended by the Federal Act of 19 December 2025 (AS 2026 164) with effect from 1 June 2026.

Second C, the consent design (Part V §20B). That a restriction on a valuable good produces a black market unless the lawful route is better than the unlawful one, that a lessor holding the residual can price below outright sale without loss, and that mandatory free servicing makes the inspection an incident of a benefit rather than an intrusion—the same visit maintaining the unit and verifying its configuration.

Second C(i), the distributive and temporal case (Part V §20B.0–20B.3). That a technology-regulation instrument under which the regulated good becomes *cheaper* is unusual enough to be named; that the levers for widening access — lease term, categorical discount, free servicing — are internal to the property relation rather than bolted on, and that no fiscal instrument has any of them because a charge reaches the machine and not the person; that adoption timing determines whether the arrangement is a norm or a confiscation of expectation, on the model of how general-purpose computing settled its terms early and by accident; and that what a reserve of numbers buys is best argued from the World Trade Center record, where robots were present within six hours and the binding constraint was the number four teams could carry.

Second D, the graduated quantity (Part V §19.1A–F). That the instrument should bind in three bands—entitlement, application, cap—rather than uniformly; that the cap belongs at the employment boundary, because displacement is an employment phenomenon and a household displaces nobody, which is why a tax charging household and warehouse alike has an incidence problem the fiscal literature has not addressed; and that **the middle band generates the deployment data from which the binding band is calibrated**, which is offered as the sharpest of these claims because no fiscal instrument has a tier of that kind—an application states an intention before deployment, where a tax return records a completed transaction afterwards and in money. Differentiation by sector, region and applicant then operates within the capped band, and is credible only because compliance with a condition on use and place is verifiable on the inspection the modification problem already requires. The three capabilities are therefore not merely compatible but mutually dependent.

Second E, the mismatch between the evidence and the instruments (Part II §5.1). The best-identified estimates of robotic substitution’s labour-market effect are constructed on local labour markets, and are identifiable at all because the effect varies from place to place. Every instrument proposed in response is spatially uniform. Naming that mismatch, and drawing from it the argument for an instrument capable of differing by place, is offered as new.

Third, quantity regulation of robotic capital as a labour-market instrument (Part V). The displacement literature is fiscal because the tools economists reach for are fiscal. A licensing regime that regulates the number of units is a different kind of instrument, it has precedents in other fields, and its costs and distortions are different in kind from a tax’s. Part V argues that it is the instrument the objective actually calls for and states honestly what it costs.

Fourth, the property route to inspection (Part V §20). That the continuing right of access which the modification problem requires can be derived from a retained proprietary interest rather than created by regulation, and that deriving it this way is both doctrinally cleaner and politically more tractable than asserting a free-standing inspection power over private homes.

Fifth, the airworthiness analogy worked out (Part VI). The analogy is not merely gestured at: the paper takes the certificate structure, the periodic inspection requirement, the airworthiness directive mechanism and the inspectorate, and asks in each case what the robotic equivalent would be and where the fit fails.

Sixth, the honest comparative conclusion (Part VIII). That a retained-interest scheme is easiest to implement in states with weak protections for private property and hardest in those with strong ones, which is a serious objection to the proposal rather than a footnote to it, and which the paper states rather than manages.

4.3 What would falsify each claim

The **joining** fails if the two problems turn out to require different kinds of persistence—if, for example, quantity control is best exercised at the point of manufacture while inspection must be exercised at the point

of use, in which case one instrument cannot do both and two are needed.

The **quantity argument** fails if a tax can in fact be calibrated to deliver a chosen quantity. That would require a reliable estimate of the relevant elasticity; Part III argues none exists and invites correction.

The **graduated quantity** fails if household-scale possession turns out to account for the bulk of aggregate displacement—through substitution for purchased cleaning, gardening, care and personal assistance—in which case the threshold is in the wrong place and the design’s distributive advantage over a tax is illusory. Part V §19.1C states that concession at its strongest.

The **calibration claim** fails if applications in the middle band systematically misstate intended use and scale, or if band-two volumes turn out not to predict industrial-band demand. The first is testable against inspection findings, and the second against any regime that collects both.

The **targeting analysis at §20D** fails if the reservation of a chattel for contingent civil-protection use is not capable of amounting to a “purpose” within the meaning of the definition of a military objective — for example because purpose is confined to uses the holder itself intends, or because a contingent statutory power is too remote to constitute an intended use at all. A persuasive argument to that effect would remove the paper’s most serious objection and the author would welcome it. It would not, however, restore the excluded tasks: a reservation extending to munitions carriage or the operation of weapons would engage the definition on any reading.

The **property route** fails if a retained interest turns out not to carry an inspection right of the required scope without express statutory provision—in which case the instrument is doing no work that a statutory power could not do directly, and the doctrinal elegance is illusory.

The **airworthiness analogy** fails if its transferable features depend on aviation-specific conditions: a small population of high-value assets, professional operators, and an accident rate that makes intrusive inspection publicly acceptable. Part VI §25 tests each.

And the **comparative conclusion** would be falsified by a workable design that is not easier for authoritarian states than for liberal ones. Part VIII §36 attempts one and does not claim to have succeeded.

Part II—The Two Problems

5. Displacement, stated at the width the argument needs

This section states the two problems at the level of generality the argument requires and no further. Our purpose is to establish what each demands of an instrument, because the claim at Parts III and IV is that the proposed instruments cannot supply it.

The displacement problem is not, for present purposes, a claim about how many jobs will be lost. This paper takes no position on the magnitude, and the argument does not require one. The magnitude is contested at both ends: the task-based tradition holds that automation raises demand for the tasks it does not replace, so that aggregate employment effects are far smaller than task-level substitution suggests,⁷ while a recent macroeconomic treatment puts the aggregate productivity effect of the current technology at a modest figure over a decade.⁸ Neither is adopted here, and nothing below turns on which is right. What the argument requires is a weaker and less contested proposition:

If robotic substitution for human labour occurs faster than labour markets adjust, the resulting harm is a function of the **rate** and not only of the eventual equilibrium.⁹

⁷David H Autor, ‘Why Are There Still So Many Jobs? The History and Future of Workplace Automation’ (2015) 29 *Journal of Economic Perspectives* 3.

⁸Daron Acemoglu, ‘The simple macroeconomics of AI’ (2025) 40 *Economic Policy* 13. Cited for the existence of a sceptical macroeconomic estimate rather than for its value, which this paper does not adopt.

⁹The proposition is deliberately weaker than the claims contested in the automation literature. It does not assert a net employment effect; it asserts only that adjustment mechanisms operate on timescales which are not themselves adjustable, so that the same eventual equilibrium is differently costly according to the speed of arrival.

That proposition is what makes the policy objective a statement about a quantity over time. A society which ends in the same place either way is differently affected according to whether it arrives over forty years or over four, because adjustment mechanisms—retraining, retirement, regional mobility, the entry of new cohorts into different occupations—operate on timescales that are not themselves adjustable. The empirical support for that is not from the automation literature but from the trade-shock literature, where exposure to import competition produced higher unemployment, lower participation and reduced wages in the affected local labour markets, and where the adjustment was slow and incomplete over a decade rather than absorbed within it.¹⁰

Two consequences follow for what an instrument must do.

It must be capable of acting on the rate, which is a quantity per unit time, rather than on the cost of the activity.

And it must be adjustable, because nobody can forecast the rate at which the technology will arrive or the rate at which a given labour market will absorb it. An instrument fixed at a level chosen in advance will be wrong, and the question is how expensive it is to be wrong.

5.1 A mismatch in the existing work, which the rest of this paper builds on

One feature of the displacement literature is worth isolating here because Part V §19.1D turns on it and it is easily missed.

The evidence is local and the instruments are national. The best-identified estimate of robotic substitution’s labour-market effect is constructed on commuting zones, and reports that one additional robot per thousand workers reduces the local employment-to-population ratio by about 0.2 percentage points and wages by about 0.42 per cent.¹¹ The trade-shock work on which the adjustment claim above rests is likewise built on local labour markets.¹² The identification strategy in both is *cross-market variation*: the whole reason these effects can be measured at all is that they differ from place to place.

Every instrument proposed in response is national. A tax rate applies across the state; a market-entry rule applies across the internal market. **The discipline has established that the phenomenon is spatially uneven and has proposed only spatially uniform responses**, and so far as the author can establish no one has remarked on the mismatch. It is not a criticism of the estimates, which are careful. It is an observation about what follows from them, and what follows is an argument for an instrument capable of differing by place—which Part V §19.1D develops and Part III explains a price instrument cannot supply.

6. Modification, stated the same way

The modification problem is likewise not a claim about frequency. It is this:

A robotic system in private possession can be altered, and a system altered outside its design envelope may be dangerous in ways neither its manufacturer nor its possessor has assessed.

Three features of the problem determine what an instrument must do about it.

It arises after acquisition. By construction. A modification is a change to something that already exists in somebody’s hands.

¹⁰David H Autor, David Dorn and Gordon H Hanson, ‘The China Syndrome: Local Labor Market Effects of Import Competition in the United States’ (2013) 103 *American Economic Review* 2121. The study exploits cross-market variation in exposure across US local labour markets between 1990 and 2007 and reports higher unemployment, lower labour force participation and reduced wages in the markets housing import-competing industries. It is cited here for the shape of the adjustment rather than for anything about trade policy.

¹¹Daron Acemoglu and Pascual Restrepo, ‘Robots and Jobs: Evidence from US Labor Markets’ (2020) 128 *Journal of Political Economy* 2188, reporting that one additional robot per thousand workers reduces the employment-to-population ratio by approximately 0.2 percentage points and wages by approximately 0.42 per cent. The magnitudes are contested in the wider literature and are stated here as the cited source states them; nothing in this paper’s argument depends on their size.

¹²Autor, Dorn and Hanson (n 10).

It is not detectable without examination. A modified unit looks like an unmodified one. Nothing about the exterior discloses the state of the firmware, and nothing about ordinary operation need disclose it either, since a modification may only manifest in circumstances that arise rarely.

And it is not necessarily malicious.¹³ The paradigm is not sabotage. It is an owner removing a speed limit, a hobbyist replacing a manufacturer’s control software with something more capable, or a small business disabling a safety interlock that slows a process. Each is comprehensible and each defeats the assessment on which the unit was approved.

The consequence is that an instrument must supply **a right to examine, exercisable during the operating life, on a unit in private possession.** Nothing else will do, because nothing else can distinguish a modified unit from an unmodified one.

7. Why they are treated separately, and why that is a mistake

The two literatures do not meet, and the reason is disciplinary rather than substantive.

Displacement is discussed by economists and tax lawyers, whose instruments are fiscal, and who reach for the tools their disciplines supply. Modification is discussed by product-safety regulators and engineers, whose instruments attach to design and market entry, and who likewise reach for what they have.

Neither discipline has an occasion to notice that the two problems share a requirement: **each needs something that persists into the operating life of the unit.** Displacement needs it because the rate must be controlled continuously as conditions change. Modification needs it because the risk arises after the moment every existing instrument attaches.

That shared requirement is the paper’s organising observation. It is not a deep insight and it does not need to be. It is simply a feature that becomes visible once the two problems are set beside each other, and they have not been.

8. What follows

Part III examines the fiscal instruments and argues that a price instrument cannot deliver a quantity and confers no access.

Part IV examines the market-entry instruments—the Machinery Regulation principally, with the Artificial Intelligence Act and the revised Product Liability Directive alongside—and argues that their obligations are complete before the risk they are asked to manage has arisen.

Part V proposes the retained interest and shows that it supplies both requirements from one structure.

Part III—Why the Fiscal Instruments Cannot Do It

9. The proposals

This section examines the fiscal response to displacement and argues that it fails on both requirements identified at Part II. The argument is not that the proposals are badly designed. It is that a price instrument cannot deliver a quantity and cannot confer access, and neither defect is remediable by better drafting.

The canonical legal treatment asks whether robots performing work a human would otherwise do should effectively bear payroll taxation as a human would, or whether firms installing them should face a special charge, and proposes an automation tax aimed at aligning the treatment of robotic and human labour.¹⁴ The proposal has been criticised on familiar grounds—that it taxes capital investment, that defining the base

¹³The paradigm cases in the text—removal of a speed limit, replacement of control software, disabling of a safety interlock—are of a kind familiar from vehicle and machinery modification generally, and none requires an intention to cause harm.

¹⁴Abbott and Bogenschneider (n 1).

is intractable, and that it would disadvantage the taxing jurisdiction.¹⁵ Those criticisms are contestable and this paper does not adopt them. Its objection is different and is structural.

The debate has recently stopped being academic, and the shape of the political proposal confirms rather than complicates the argument here. In October 2025 the minority staff of a United States Senate committee proposed ‘a robot tax on large corporations’, in the form of ‘a direct excise tax’ on artificial intelligence and automation, with the wealth those technologies create ‘redistributed back to the workers impacted’.¹⁶ Whatever one thinks of it, note what it is: a proposal about **revenue and its distribution**. It says nothing about how many units are deployed, nothing about where, and nothing about what may be done to a unit after it is sold—not because the drafters overlooked those questions but because a fiscal instrument has no way of reaching them. That is this Part’s claim, arriving from the direction of practice.

10. A price instrument cannot deliver a quantity

The point is elementary and its consequences are not.

A tax alters the cost of an activity. It leaves the decision whether to undertake the activity with the person bearing the cost. The distinction between price and quantity instruments, and the conditions under which each is preferable, is the subject of a settled literature in regulatory economics, and the governing consideration is which of the two the regulator can specify with more confidence—the price at which the desired quantity results, or the quantity itself.¹⁷ The quantity that results is therefore whatever quantity that person chooses at the new price, which depends on the elasticity of their demand—and the elasticity is not known, is not stable, and differs across firms, sectors and time.

Three consequences follow.

A policy objective stated as a rate cannot be delivered. If the objective is that substitution should proceed no faster than labour markets absorb it, that is a statement about a quantity per unit time. A tax delivers a quantity only through an elasticity, so setting the tax to deliver the target requires knowing the elasticity. Nobody does. What is delivered is a quantity nobody chose.

Ability to pay determines who is constrained.¹⁸ A charge constrains the firm for which automation is marginal and does not constrain the firm for which it is decisive. Since the firms for which automation is most decisive are generally the largest, a tax at any politically feasible level operates principally on the smallest adopters. Whatever the distributional intention, that is the incidence.

And the instrument’s flexibility is poor where flexibility is what the problem demands. Part II §5 established that an instrument must be adjustable, because the rate of arrival cannot be forecast. A tax rate is set in legislation and changed by legislation, which is slow and expensive in political capital. An instrument that must be re-legislated to be adjusted will be adjusted late.

None of this shows a tax to be useless. A tax raises revenue, and revenue funds the adjustment measures that the displacement problem also requires. **The claim is narrower: a fiscal instrument is a revenue**

¹⁵Atkinson (n 4).

¹⁶Minority Staff, United States Senate Committee on Health, Education, Labor and Pensions, *The Big Tech Oligarchs’ War Against Workers: AI and Automation Could Destroy Nearly 100 Million U.S. Jobs in a Decade* (6 October 2025) <https://www.sanders.senate.gov/wp-content/uploads/10.6.2025-The-Big-Tech-Oligarchs-War-Against-Workers.pdf> accessed 16 October 2026, Executive Summary and section V. The report is a recommendation of the committee’s minority staff, not a legislative text; the description in the text is of the proposal as the report states it, and nothing in this paper’s argument depends on the proposal’s fate.

¹⁷Martin L Weitzman, ‘Prices vs. Quantities’ (1974) 41 *Review of Economic Studies* 477. Weitzman’s question is which of the two modes of control minimises expected welfare loss where the regulator is uncertain about costs, and his answer turns on the relative curvature of the benefit and cost functions rather than on any general superiority of either. The argument here is narrower and should not be presented as an application of his result: this paper’s objective is stated as a quantity rather than as a welfare target reached through one, and the decisive consideration at §11 is a capability—access—which falls outside the comparison Weitzman conducts altogether.

¹⁸The incidence point is a corollary rather than an additional claim: a charge binds the marginal decision and leaves the inframarginal one untouched, so the firms for which substitution is most valuable are the firms a feasible charge constrains least.

instrument and a price signal, and the displacement problem’s temporal dimension is a quantity problem. Using the first to address the second is a category error rather than a calibration failure.

11. A price instrument confers no access

This is the shorter point and the more decisive one for this paper’s argument.

Taxing a thing gives the state no entitlement to examine it. A revenue authority may audit the taxpayer’s records, and it may require information relevant to assessing the charge; it may not enter a person’s premises to establish whether a machine has been modified, because the modification is not relevant to the amount due.

That is why no fiscal proposal has ever been offered as an answer to the modification problem, and why no critic of fiscal proposals has thought to raise the omission. The two are simply not in the same conversation.

The consequence for this paper is that **any state pursuing the fiscal route must build a second instrument for modification**, and the second instrument will have to justify a power of examination over private property from first principles. Part V’s argument is that a single structure supplies both, and §11’s observation is what makes that a saving rather than an elegance.

12. The tempting middle case, and why it fails

One response deserves treatment because it is the obvious repair: a tax with conditions attached, so that a favourable rate is available only to possessors who submit to inspection.

That does work, up to a point, and something like it exists in other fields. Two difficulties defeat it here.

It converts inspection into a bargain rather than an obligation. A possessor who prefers the higher rate declines the inspection, and the units most likely to be modified are the units whose possessors most value being left alone. The instrument selects against its own purpose.

And it does not touch quantity. Whatever the rate structure, the number of units remains whatever purchasers choose at the resulting prices. The middle case addresses the access problem imperfectly and the quantity problem not at all.

13. What survives of the fiscal case

Two things, and they should be stated because this Part has been critical.

Revenue is necessary. Adjustment costs money—retraining, income support, regional measures—and a levy on the beneficiaries of substitution is a defensible way to raise it. Nothing in this paper argues against taxing robotic capital for revenue.

And a price signal is a legitimate secondary instrument. Where the objective is to discourage substitution at the margin rather than to cap it, a charge does that.

The argument is only that neither addresses the two requirements at Part II. A fiscal instrument alongside a quantity instrument is coherent; a fiscal instrument instead of one is not.

Part IV—Why the Market-Entry Instruments Cannot Do It

14. The instruments, and what they require

This section examines the product-safety response to modification. Our purpose is to establish that its obligations are complete before the risk arises, which is a structural feature rather than a drafting oversight, and that the recent instruments make the point sharper rather than answering it.

Three instruments now converge on robotic systems placed on the European Union market.

The Machinery Regulation applies from 20 January 2027, replacing the Machinery Directive.¹⁹ It is the general product-safety instrument for machinery, and for the first time it addresses tampering directly: machinery must be designed and constructed so that connecting another device does not lead to a hazardous situation, and control systems and software must be secured against tampering and unauthorised modification.²⁰

The Artificial Intelligence Act applies risk-tiered obligations to systems within its scope, with horizontal transparency obligations that became applicable on 2 August 2026; since its amendment in July 2026 its requirements for high-risk systems are to reach artificial intelligence in machinery through the Machinery Regulation itself, by August 2028.²¹

And the revised Product Liability Directive brings software—embedded or standalone, however it is supplied, and including, as its recitals state, artificial intelligence systems—within the definition of a product, empowers a court to order disclosure of evidence against a defendant, and creates rebuttable presumptions of defectiveness and causation where a claimant faces excessive difficulties of proof owing to technical complexity. Member States must transpose by 9 December 2026.²²

Taken together these are substantial obligations, they are recent, and the compliance burden they place on manufacturers is real. This paper is not arguing that the field is unregulated.

15. The temporal defect

Every obligation above attaches to a moment, and the moment is placing on the market.

The Machinery Regulation goes further than is generally noticed, and the detail makes this paper's point rather than answering it. Annex III, point 1.1.9, headed “Protection against corruption”, requires that machinery be designed and constructed so that the connection to it of another device, directly or remotely, does not lead to a hazardous situation; that a hardware component giving access to software critical for compliance, and the software and data critical for compliance, be adequately protected against “accidental or intentional corruption”; that the machine identify the software installed on it that is necessary for it to operate safely and be able to provide that information at all times; and—the requirement that matters most here—that **the machine “collect evidence of a legitimate or illegitimate intervention in the software or a modification of the software installed on the machinery or related product or its configuration”**.²³ Point 1.2.1(f) adds that the tracing log of the data generated in relation to an intervention, and of the versions of safety software uploaded after the machine has been placed on the market, be enabled for five years after each upload.

Read that last requirement carefully. The Union has legislated that a machine must collect evidence of intervention in its software, and of modification of that software or of its configuration, whether the intervention

¹⁹Machinery Regulation (n 2).

²⁰ibid, Annex III, points 1.1.9 and 1.2.1, on the requirement that machinery be designed and constructed so that connection of another device does not lead to a hazardous situation, and that control systems and software be secured against tampering and unauthorised modification.

²¹Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence [2024] OJ L, 2024/1689, 12.7.2024, arts 50 and 113, as amended by Regulation (EU) 2026/1744 of the European Parliament and of the Council of 8 July 2026 (Digital Omnibus on AI) [2026] OJ L, 2026/1744, 24.7.2026, which entered into force on 27 July 2026. Article 113 makes 2 August 2026 the general date of application, and art 50 has applied from that date, save that providers of generative systems placed on the market before it have until 2 December 2026 to comply with art 50(2) (art 111(4)). The amending Regulation defers the obligations in Chapter III, Sections 1 to 3, to 2 December 2027 for high-risk systems within Annex III and to 2 August 2028 for those within Annex I, and moves the Machinery Regulation to Section B of Annex I, so that the requirements for high-risk systems in machinery are to be written into Annex III of the Machinery Regulation by delegated acts applying by 2 August 2028: Regulation (EU) 2026/1744, art 1, points (39) to (41), and art 3(1).

²²Directive (EU) 2024/2853 of the European Parliament and of the Council of 23 October 2024 on liability for defective products [2024] OJ L, 2024/2853, 18.11.2024, art 4(1) (product includes software) and recital 13 (software, including AI systems, irrespective of the mode of its supply), arts 9 and 10, and art 22 on transposition by 9 December 2026.

²³Machinery Regulation (n 2), Annex III, point 1.1.9 (‘Protection against corruption’), and point 1.2.1 (‘Safety and reliability of control systems’). The duty to collect evidence of intervention is in the second and fifth paragraphs of point 1.1.9; the tracing log is at point 1.2.1(f).

is legitimate or not. The evidence this paper’s inspection regime would look for is therefore already required to exist, by law, inside the unit.

And the route to that evidence is narrow and runs through the manufacturer. The obligation is on the manufacturer, to design a machine that collects the evidence and keeps the log. The log is enabled “exclusively to demonstrate the conformity of the machinery or related product with this Annex further to a reasoned request from a competent national authority”, and the request the Regulation contemplates is a market-surveillance request about conformity, made under the powers described at §16 and addressed to the economic operators who placed the product on the market.²⁴ What the Regulation does not do is create any relationship with the possessor: no provision obliges the person in whose home the unit sits to retain, present or disclose anything, and no provision requires anyone to find out whether a unit three years into its life has been altered. **The instrument compels the creation of the record and opens it only for the purpose, and through the parties, of market entry.** That is the point-in-time defect in its sharpest available form, and it is a stronger illustration than anything this paper could have constructed: the legislature has accepted the premise, mandated the evidence, and provided a route to it that stops at the economic operator.

The Machinery Regulation’s tampering provisions are design obligations. They require that the machine be *designed and constructed* so that unauthorised modification is prevented or made difficult. That obligation is discharged when the machine is designed and constructed. It is a good obligation and it will make modification harder. It says nothing whatever about a unit in a possessor’s hands three years later on which the protection has been defeated, and it imposes no duty on anyone to find out.

The Artificial Intelligence Act’s obligations likewise attach to providers and deployers in respect of systems as placed on the market and as used, but its enforcement architecture is supervisory over economic operators rather than inspectorial over possessed units.

And the Product Liability Directive operates after harm. It is a liability instrument: it allocates loss once somebody has been injured, and its considerable improvements—the software definition, the disclosure power, the presumptions—all make it easier to succeed in a claim that arises because something has already gone wrong. A liability rule cannot prevent a modification; it determines who pays after the modification has caused injury.

The pattern is the same one this paper identified at Part I §1. **The instruments attach at manufacture, at placing on the market, or after harm. The modification risk arises between the second and the third, and nothing occupies that interval.**

16. Why this is structural rather than a gap to be filled

The obvious response is that the Machinery Regulation could simply be extended to impose continuing obligations. Two difficulties.

On whom? The manufacturer has no relationship with the unit after sale, no right to inspect it, and no means of compelling anything. Placing a continuing obligation on a manufacturer in respect of a chattel it does not own and cannot access would be an obligation it cannot discharge. Placing one on the possessor requires somebody with a right to verify compliance, which returns to the access problem.

And with what power of examination? A continuing obligation is worth what its enforcement is worth. Enforcement requires examining units in private possession, which requires a power to enter and inspect, which is exactly the thing that has to be justified. The Union’s market-surveillance framework does confer substantial investigative powers, and they are worth stating precisely because the objection is that they already suffice. They are conferred on authorities in respect of *products made available on the market* and are directed at economic operators; they are to be exercised proportionately and by reference to the non-compliance in question; and they are subject to the Charter, to national procedural safeguards and to

²⁴Machinery Regulation (n 2), Annex III, point 1.2.1(f); and see art 10(3), under which the source code or programming logic included in the technical documentation is to be made available to the competent national authorities on a reasoned request where it is necessary for them to check compliance with Annex III. On the market-surveillance powers through which such a request is made, see §16.

the data-protection rules.²⁵ Nothing in that architecture contemplates routine, scheduled examination of a chattel in a person’s home which is not suspected of anything and whose possessor is not an economic operator at all. **The framework has no such power because it has never needed one: its subject is an economic operator placing goods on a market, not a citizen in a house.**

That is why the defect is structural. **Market-entry regulation regulates a transaction. The modification problem is a property in a thing that persists after the transaction is complete.** An instrument aimed at the first cannot reach the second without acquiring a power that has nothing to do with market entry—at which point the question is what justifies the power, and Part V’s answer is a retained proprietary interest.

17. What the Machinery Regulation does establish

Two things, and both help the argument rather than hindering it.

It establishes that tampering is a recognised regulatory concern. The tampering provisions are new, and their inclusion records a legislative judgement that unauthorised modification of machinery is a hazard warranting a response. This paper does not have to argue that the problem is real; the Union has legislated on the footing that it is.

And it establishes the standard against which modification would be measured. A unit’s approved configuration—what it was designed and constructed to be—is documented as part of the conformity assessment. That documentation is what an attestation-based inspection under Part V §20.3 would compare against. **The market-entry regime supplies the reference; what it lacks is anybody entitled to check a unit against it.**

Part V—The Retained Interest

18. What is retained, and what is not

This section specifies the instrument. Our purpose is to state precisely what the state holds and what the possessor holds, because the objections at Part VII turn on the allocation and a vague statement of it would let the argument escape them.

The structure is a lease. The state holds the reversion; the possessor holds a leasehold interest in the unit for a term.

The possessor holds exclusive possession, the right to use the unit for any lawful purpose, the right to exclude others including the state save under the inspection provision, the right to quiet enjoyment, and the right to assign the lease subject to the same conditions. Those are substantial rights and they are the ordinary content of a leasehold. A possessor is not a bailee, a licensee at will, or a person permitted to use state property on sufferance.

The state holds the reversion, the power to grant or refuse a new lease where the number is regulated, a right of inspection defined by statute and limited as §20 sets out, a reserved right of temporary recall in a declared emergency as §20A sets out, and a right of forfeiture on breach.²⁶ It does not hold a general right

²⁵Regulation (EU) 2019/1020 of the European Parliament and of the Council of 20 June 2019 on market surveillance and compliance of products [2019] OJ L169/1, art 14 (powers of market surveillance authorities). Article 14(2) requires those powers to be exercised efficiently, effectively and proportionately by reference to the subject matter and purpose of the measure and to the harm resulting from the non-compliance, and in accordance with the Charter of Fundamental Rights and the Union rules on data protection. Article 14(4) directs its information and entry powers at economic operators: to require them to provide documents, data or information on compliance, ‘including access to embedded software in so far as such access is necessary for the purpose of assessing the product’s compliance’ (point (a)), and to enter premises they use for their trade or business (point (e)).

²⁶The allocation described is that of an ordinary lease: the lessor retains the reversion and such rights as are reserved, and the lessee takes the residue for the term. Nothing in the structure is novel; what is novel is the class of chattel to which it is applied.

to use the unit, a right to the data the unit generates, or a right to enter the premises where the unit is kept save as the inspection provision permits.

The recall right has to be listed here rather than introduced later, because a reserved right that appears for the first time three sections after the allocation has been stated is not reserved—it is added. Its limits are at §20A.4 and it is confined to the emergency the statute defines; outside that, the state's want of a right to use the unit is complete.

The term is the design life or a fixed period, whichever is shorter, renewable on inspection. Renewal is a formality in the entitlement band at §19.1A and is the point at which the quantity is applied in the bands above it.

19. Quantity, and why this is the instrument the objective calls for

19.1 What quantity regulation does that a price instrument cannot

Part III established the general point and this section applies it.

This section states the quantity argument in its simplest form, in which every lease is granted or refused. §19.1A then replaces that with the graduated form the paper actually proposes, in which the power to refuse is confined to the industrial band. The simple form is set out first because the argument against a price instrument does not depend on the graduation, and because the graduation is better understood as a limit on a general power than as a patch on a broken one.

A lease is granted or refused. The number of leases in existence at any time is therefore a quantity the granting authority sets, directly, without any estimate of anyone's elasticity of demand and without any assumption about what firms will pay. If the policy objective is that the stock of substituting capital should grow at a rate the labour market can absorb, that objective is a statement about a quantity, and a quantity instrument delivers it by construction where a price instrument delivers it only by inference.

Three consequences follow and the second is the one usually missed.

The target is stated rather than inferred. A licensing authority publishes the number of leases it will grant in a period. Whether that number is right is a political judgement, and Part III argued it cannot be derived; what quantity regulation supplies is that the judgement is made openly by somebody accountable for it, rather than emerging from an elasticity nobody measured.

Adjustment is possible without renegotiation. A tax rate set in legislation is changed by legislation, slowly and with the whole political cost paid again. A licensing quantity is an administrative decision within a statutory frame, adjustable annually as conditions change. For a problem whose pace nobody can forecast, that flexibility is worth a great deal, and the strongest practical argument for this instrument over a fiscal one.

And the distributional question becomes explicit. A tax distributes by willingness to pay, which means by ability to pay, quietly. A licensing regime must state its allocation rule—first come, auction, sectoral quota, essential-use priority—and defend it. That is uncomfortable and it is better: the distribution happens either way, and an instrument that forces it to be stated is more honest than one that lets it happen silently.

19.1A The quantity is graduated, and the graduation is what retained title makes cheap

The account at §19.1 treats the permitted quantity as a single number applied uniformly. That is the weakest possible version of the instrument and it is the version critics of quantity regulation attack. The instrument this paper proposes is graduated, in three bands, and each band does something the others cannot.

Band one: possession as of right. Below a stated number—illustratively three units for a household, one for a single-person household—possession requires no application and no permission. The possessor takes an agreement on standard terms and is registered; nothing is refused and nothing is queued. The state's

interest is retained, so the modification and recall provisions apply, but the quantity provision does not bind because nothing in this band is being rationed.

Band two: possession on application, which is not the same as possession on permission. Above the entitlement and below the industrial threshold, an agreement is granted on an application stating the intended use, the place of use and the number sought. **The application is not designed to refuse. It is designed to be answered.** Refusal in this band should be exceptional and reasoned, and the instrument's purpose here is not restriction but disclosure: the state learns what is being acquired, by whom, for what, and where, before it is deployed.

Band three: the cap, which binds. At industrial scale—illustratively six or more units, or possession by an undertaking for use in its trade—the number is limited, and limited by reference to identified occupational classes in an identified area. This is the only band in which the quantity instrument does what a quantity instrument is for, and it is deliberately the narrowest.

The graduation is available because the state holds the title. A regime built on permission alone must justify every tier of its own intrusion; a regime built on a retained proprietary interest already has the relationship, and the tiers are terms in an agreement the possessor entered rather than powers asserted over a stranger.

The structure is not an invention. British goods-vehicle licensing has exactly this shape: private use engages nothing, use “for or in connection with any trade or business” requires an operator's licence,²⁷ the licence “shall specify a maximum number for motor vehicles”,²⁸ and the vehicles must be operated from a centre within the area for which the licence was issued.²⁹ The regime originated in the Transport Act 1968, has run continuously since operators' licensing came into operation in March 1970, and was extended in 1982 to the environmental control of operating centres.³⁰ A quantity, attached to a stated place, imposed only on business use, over privately possessed chattels, administered continuously for fifty-six years. What is proposed here is that structure applied to a different chattel, with the addition of the retained title which the vehicle regime does not have and which is what supplies the inspection and recall capabilities at §20 and §20A.

19.1B What the middle band is for, and this has no fiscal analogue at all

Part III conceded that the right quantity cannot be derived, because nobody knows the relevant elasticity. §19.1 conceded it again, and treated the number as a political judgement made openly rather than a technical one made correctly. Both concessions stand. What band two supplies is the thing that makes the judgement improve.

An application states an intention. A tax return records a transaction. The difference is the whole of this section. A fiscal instrument can be calibrated only from outcomes it has already produced, recorded in money, after the deployment has happened. Band two produces a forward record—use, place, scale, sector—**before** deployment, from applicants who have no reason to misstate it because the application is not a filter.

That yields three things.

The instrument generates the information required to set its own binding tier. The cap in band three is defensible only if somebody can say which occupational classes in which places are actually exposed. Band two is where that is learned, and it is learned from the people acquiring the machines rather than inferred from aggregate statistics published eighteen months late.

²⁷Goods Vehicles (Licensing of Operators) Act 1995, s 2(1), which requires an operator's licence for the use of a goods vehicle for hire or reward or “for or in connection with any trade or business carried on by him”. The Act consolidates Part V of the Transport Act 1968, in which the operator-licensing regime originated.

²⁸*ibid*, s 6(1)(a).

²⁹*ibid*, s 5(4), which requires the operating centre of a heavy goods vehicle to be in the traffic area in respect of which the licence was issued.

³⁰Operators' licensing under the 1968 Act came into operation in March 1970: HC Deb 24 March 1970, vol 798, cols 1189–91. The environmental control of goods vehicle operating centres was introduced by the Transport Act 1982, s 52, repealed on the consolidation of 1995 by the Goods Vehicles (Licensing of Operators) Act 1995, s 60(2) and Sch 8, Pt I.

The disclosure is cheap because it is not a restriction. An application that will be granted costs the applicant a form and costs the state a clerk. It is the least invasive way of obtaining deployment data that the author can identify, and it is obtainable at all only because the state is a party to the possession rather than a stranger taxing it.

And a rising band-two caseload is itself the signal. The number of applications in a sector, in a region, in a quarter is a leading indicator of substitution in that sector and region. No fiscal instrument produces a leading indicator; a tax produces a lagging one and produces it in aggregate.

The honest limit is that this is a data-collection power and should be named as one. It is bounded in §20.2's terms—the register records units, uses and places, not what any unit has done—and by the entitlement band, which means the great majority of possessors never appear in it. An instrument whose information-gathering tier reached every household would be a different and worse proposal.

19.1C Why the cap sits at the employment boundary, and what that concedes

Displacement is an employment phenomenon. A household holding three units employs nobody and displaces nobody directly. An undertaking holding sixty is substituting for wage labour, which is the entire subject of Part II.

Two consequences follow and the second is a criticism of the fiscal literature rather than of the proposals within it.

The restriction falls where the gain is captured. An instrument that binds at the industrial threshold and nowhere else imposes its cost on the party realising the benefit of substitution. That is not a distributional nicety; it is what makes the scheme politically survivable, and it is the answer to the objection at §27 that rationing reserves the technology to those who can afford it. Under this design ordinary households are not rationed at all.

A robot tax, by contrast, charges the household. A charge on the acquisition or use of a robotic system falls on the retired person buying one unit and on the logistics operator buying six hundred, and it falls on the first as a proportion of income that it does not on the second. The fiscal literature argues about rates, bases and incidence between firms; it has not addressed the incidence between a firm and a household, because a tax base defined on the machine cannot distinguish them. **A quantity instrument graduated at the employment boundary does distinguish them, and it does so by construction rather than by exemption.**

The concession is real and should be stated at its strongest. **Household units do displace labour—just not the household's own.** A domestic unit substitutes for purchased services: cleaning, gardening, some kinds of care and personal assistance. Those are real jobs held disproportionately by low-paid workers, and an entitlement band set at three units per household concedes that substitution entirely. The answer available is weak but honest: the entitlement number is a policy variable rather than a fixed feature of the design, band two is precisely where the aggregate effect of household substitution would become visible, and an instrument that made the effect visible is better placed to respond to it than one that never counted.

19.1D Differentiation within the capped band

Within band three the number need not be uniform, and the ability to differentiate is a larger advantage than the ability to set a total.

By sector. Labour markets do not displace uniformly. A state may permit substitution freely where labour is scarce and the work is dangerous or unfilled—care, agriculture at harvest, contaminated and confined-space work—while restricting it where displacement would fall on a large, concentrated workforce with poor alternatives. Those are opposite policies and one instrument must be capable of both at once.

By region. This is the differentiation that matters most and it is the one the fiscal literature cannot reach. **Displacement is not a national aggregate; it is a set of local events**, and Part II §5.1 makes the point that the empirical literature already knows this: the effect of robotic substitution is identified on commuting zones, and the trade-shock work on which the adjustment claim rests is built the same way. A regional

economy with tight labour and diversified employment absorbs substitution without political rupture. A single-industry town does not, and the political consequences of automation have historically been produced by the second case while being measured by the first. A licensing quantity can be set per region, on regional labour data, and adjusted as those data move.

By undertaking. An allocation rule may distinguish new entrants from incumbents, small undertakings from large, or first applications from expansions. Without such a rule the whole permitted quantity is taken by whoever applies first with the most resources.

19.1E Why a tax cannot do this, and it is not for want of trying

The obvious reply is that a tax can be graduated and differentiated too—a threshold below which no charge arises, higher rates above it, different rates by sector and region. Such structures exist in many systems and there is nothing conceptually novel about them.

Three difficulties defeat it, and the third is decisive.

Base definition. A differentiated tax must define the categories in the tax base, and “a robot used in warehousing” or “a robot deployed in this region” are characterisations a taxpayer states and an authority must accept or challenge. The categories are recharacterised at the boundary, which is the ordinary experience of every differentiated tax, and the recharacterisation is cheapest for the largest taxpayers. A graduated tax invites the same treatment at the threshold: units are held in separate entities until each falls below it.

Legal exposure of regional differentiation. Charging different rates in different regions of one state raises questions of selectivity and of equal treatment which vary by constitutional order and which, within the Union, engage the State aid discipline directly where the differentiation favours undertakings in particular areas. A licensing quantity set regionally is a regulatory measure of general application in that region, which is a materially different legal object.

And enforceability, which is the point. A differentiated tax must be able to verify that the taxpayer’s stated category is the true one, and it has no means of doing so beyond the taxpayer’s own records. **A differentiated licence conditions possession on a stated use in a stated place, and the retained interest supplies the means to verify both:** the unit is physically somewhere and doing something, and §20’s inspection establishes that it is the somewhere and the something the agreement specified. The same answers the threshold-splitting problem, because the condition attaches to units in use at a site rather than to units on a balance sheet.

That is the three capabilities reinforcing one another rather than merely coexisting. Graduation and differentiation are credible only where compliance with the condition can be checked. A tax cannot check it. A property relationship can, because the inspection right is already there for the modification problem and costs nothing further to use for this one.

19.1F What the graduation costs

Three, and they are additional to the general costs at §19.2.

Bunching and structuring at each threshold. An undertaking sized just below the industrial threshold, or a group of related households each holding the entitlement, defeats the design. The answer is that the operative test is units in use at a site in a trade rather than units held by a legal person, that this follows the goods-vehicle regime’s operating-centre logic, and that it is verifiable on the inspection the scheme already provides. It is not a complete answer and no threshold regime has one.

Geographically variable rent. Where the permitted quantity in band three is tighter in one region, the agreement is worth more there and the difference is capturable. That is a real distortion and the honest response is that it is the price of an instrument capable of regional adjustment at all.

And a substantial planning power exercised locally. Setting regional quantities is a significant economic decision taken close to the affected interests, which is where capture is easiest and lobbying cheapest.

The drafting at Part IX answers this only by requiring publication of the number, the rule and the reasons, which makes the decision reviewable rather than incorruptible.

19.2 What it costs, stated honestly

Quantity regulation has well-known pathologies and they should be conceded before the objections Part is reached.

It creates a **rent**. Where the permitted quantity is below the market-clearing quantity, the licence is worth something, and whoever receives it captures that value. Auctioning recovers the rent to the state and reintroduces allocation by ability to pay; administrative allocation avoids that and invites capture. There is no arrangement that avoids both.

It creates an **administrative burden and a point of capture**. Somebody decides the number and somebody decides who receives leases, and both decisions attract lobbying of a kind a general tax does not.

And it is **crude where the tax is fine-grained**. A tax can discriminate by capability, sector or displacement effect through its base and rate. A licence is granted or not.

Those are real costs. The argument of this paper is not that quantity regulation is costless but that it is the instrument capable of the stated objective, and that it comes with a second capability—the access at §20—which no fiscal instrument can supply at any price.

20. Access, and why it follows from the property rather than being imposed alongside it

20.1 The doctrinal point

A lessor with a reversionary interest has an interest in the condition of the thing let. Rights of entry to inspect for want of repair, and covenants requiring the lessee to permit inspection, are ordinary incidents of a lease and require no special justification: the lessor is protecting an interest they retain rather than exercising a power over a stranger's property.³¹

English law does not leave that to be inferred. Where a statute implies a repairing covenant by the lessor into a short residential lease, it implies alongside it a covenant by the lessee that the lessor “may at reasonable times of the day and on giving 24 hours' notice in writing to the occupier, enter the premises comprised in the lease for the purpose of viewing their condition and state of repair”.³² Three features of that provision are worth taking rather than merely noting.

The right is expressed as a correlative of the repairing obligation, not as a power. Parliament implied it because the lessor is answerable for the condition of the thing, and a party answerable for a condition must be able to see it. That is a reason, and it is a reason available to this scheme in a way it is not available to a regulator.

It is bounded on its face—reasonable hours, written notice, and a stated purpose from which the scope of the visit is read.

And its predicate is an obligation the lessor has assumed. That has a consequence for §20B which was not obvious when this paper's design was settled and which is now offered as part of the argument rather than as an incident of it. **Mandatory free servicing is not only the political sweetener it appears to be; it is the doctrinal predicate for the inspection right.** A state that supplies the unit, retains the reversion and undertakes to maintain it stands in the position s 11(6) contemplates, and the entitlement to view the condition of the thing follows from the undertaking to keep it in condition. A state that retained

³¹The lessor's interest in the condition of the demised property, and the correlative right to inspect, are standard incidents of the relationship and are ordinarily provided for expressly by covenant. The point in the text is that the entitlement is explicable by reference to the retained interest rather than requiring independent justification.

³²Landlord and Tenant Act 1985, s 11(6). The covenant is implied only where the lessor's repairing covenant under s 11(1) is itself implied, which is the point made in the text: the entitlement to view follows the obligation to keep in repair.

the reversion and undertook nothing would be asserting a bare right of entry, which is a materially weaker position.

That is the doctrinal move, and its value is what it avoids. The alternative—a free-standing statutory power to enter private premises and examine private chattels—must be justified from scratch, is politically difficult, sits uneasily with protections against arbitrary interference with the home, and would have to be defended against every future proposal to extend it. **A right derived from a retained proprietary interest is defended by the property relationship that created it, and is bounded by the same relationship.**

The paper should be honest about two limits. A statute could confer the same inspection power directly, so what the property route supplies is a coherent account of *why* the state may look rather than a power otherwise unobtainable. And s 11(6) governs land rather than chattels, so it is offered as the clearest statutory articulation of the principle rather than as authority directly in point; the chattel equivalent is ordinarily an express term in an equipment lease, which proves the principle is unremarkable but proves it less tidily.

20.2 The scope of inspection, defined narrowly

The inspection right is limited by statute to:

The physical integrity of the unit—whether it has been modified, and if so how.

The provenance and integrity of the software it runs—whether the code is what the type approval contemplated, established by comparison against a published attestation rather than by extraction and reading of the code.

The functioning of its safety-related constraints—whether limits imposed at manufacture remain in force.

And, where the agreement conditions use by place and sector, where the unit is kept and the trade in which it is in use—established by what the inspector observes at the visit, and never from anything the unit holds.

It does not extend to what the unit has observed, recorded, or been used for. That distinction is the paper’s answer to the surveillance objection and it is load-bearing, so §20.3 states how it is enforced rather than merely asserted.

20.3 How the limit is made real

Three mechanisms, and none of them is a promise.

Attestation rather than extraction. The unit computes and presents a cryptographic attestation of its software state. The Protocol is set out step by step in the Appendix, because the claim that it yields one bit and nothing else is load-bearing for the answer at Part VII §30 and should not be taken on trust. The inspector compares that value against the published value for the approved configuration. A mismatch establishes modification; a match establishes conformity. **At no point does the inspector read the code, the logs, or the data.** The inspection yields one bit of information about the software and nothing else, and it yields it without the inspector having access to anything from which more could be inferred.

An independent body holds the right. The inspection power is vested in a body constituted for the purpose, at arm’s length from the executive and from police and security functions, with a statutory bar on disclosure of anything incidentally learned. That is the airworthiness model and Part VI treats it.

And the scope is a jurisdictional limit rather than a policy. An inspection exceeding the statutory scope is unlawful, the evidence obtained is inadmissible, and the possessor has a remedy. A limit which merely instructs inspectors to be restrained is not a limit.

20A. The third capability: requisition without expropriation

The two capabilities at §19 and §20 were the paper’s original claim. A third follows from the same structure, it is more consequential than either, and it inverts the property objection at Part VII rather than merely

surviving it.

20A.1 The difficulty requisition ordinarily faces

A state facing an emergency—armed attack, natural disaster, epidemic, mass displacement—may need physical capability at a scale and speed no procurement cycle supplies. Robotic systems are exactly the capability it would want: logistics carriage, casualty movement, debris clearance, contaminated-area work, perimeter observation.

Under ordinary property arrangements, taking them is expropriation. It engages the protection of possessions, requires a legal basis, must be proportionate, and attracts compensation.³³ It is slow, contestable and expensive, and a state which has to litigate its way to a fleet does not have a fleet when it needs one.

20A.2 What the retained interest changes

If title never passed, there is nothing to take.

A state recalling units under a term reserved in the possession agreement is **exercising a right it always held in its own chattel**. That is not a deprivation of the possessor's property, because the possessor's property was a leasehold interest defined from the outset as subject to recall. It is the enforcement of a bargain, on terms published before anyone entered it.

The legal difference is not presentational and it should be stated precisely. **Expropriation asks whether the state may take what is yours. Recall asks whether the state may have back what is its own.** The first is a hard question answered slowly. The second is a question about the construction of an agreement.

20A.3 What that yields, and it is substantial

A latent civil reserve, funded privately. Every leased unit is capability the state can call on without having procured it, stored it or paid to hold it idle. The possessor buys the machine for their own purposes and bears its cost; the state holds a contingent claim on it. In effect **private consumption expenditure becomes a defence and civil-contingency reserve**, and the one standing cost to the public purse is the servicing the state undertakes at §20B, which is also its inspection.

Speed. Recall under a reserved term requires an administrative act, not a legal process. There is no question of title to resolve, no valuation to agree, and no expectation to defeat.

And an argument that makes the scheme easier rather than harder to justify. Part VII §26 treats the retained interest as a burden requiring justification. This section shows it is also the source of a capability which a state would otherwise have to obtain by expropriation. Whether that makes the scheme more attractive or more alarming depends on the reader's view of the state proposing it, and §20A.5 addresses that directly.

20A.4 The exemptions, which are not concessions but requirements

Recall cannot be general, and two limits are necessary rather than diplomatic.

Care and assistance units must be exempt. A robotic system performing personal care, mobility assistance or medical support for a disabled or elderly person is not a fungible asset. Its removal causes harm directly and immediately, and a state which recalled it would be creating the emergency it claimed to be answering. The exemption should be absolute rather than discretionary, because a discretion exercised under emergency pressure is not a protection.

And recall must be time-bounded, compensated for loss of use, and reviewable. A reserved right exercised indefinitely is expropriation by another name, and drafting it as a temporary recall with a payment

³³Protocol to the Convention for the Protection of Human Rights and Fundamental Freedoms (adopted 20 March 1952, entered into force 18 May 1954) ETS 9, art 1, which protects the peaceful enjoyment of possessions while preserving the right of a State to control the use of property in accordance with the general interest.

for the period of dispossession keeps the characterisation honest. That is not a concession to the objection; it is what makes the characterisation accurate.

20A.5 The objection this invites, stated before it is made

A reader who has followed the argument to here should be uneasy, and the unease is the right response.

A scheme which makes every domestic robot a contingent state asset is a scheme which gives a government physical capability inside private households, callable on its own declaration of emergency. That is a considerable power. It is more considerable than the inspection right at §20, because inspection yields information and recall yields machines.

Three things bound it and none of them makes it comfortable.

The trigger must be statutory and reviewable, not executive. Recall on a minister's declaration is a different instrument from recall on a statutory trigger with judicial review and parliamentary reporting. The drafting at Part IX adopts the second.

The exemptions must be absolute. §20A.4's care exemption is the principal one, and it should not be capable of suspension by the same emergency power that authorises the recall.

And the capability is honestly stated rather than minimised. This paper's position is that a state which can requisition robotic capability in an emergency without expropriating anything is materially more capable than one which cannot, that this is a good reason to adopt the scheme and simultaneously a good reason to fear it, and that the resolution is in the quality of the constraints rather than in denying the power exists.

20B. Consent, and why the scheme must be attractive rather than merely lawful

A scheme of this kind fails if people resent it, because a resented restriction on a valuable good produces a black market, and a black market defeats every one of the three capabilities at once: unlicensed units are uncounted, uninspected and unrecalable.

The answer is not enforcement. It is that **the lawful route must be better than the unlawful one**, and the retained interest supplies the means to make it so.

20B.0 The proposition stated positively, because the defensive framing understates it

Everything below is written as an answer to an objection: how do you stop people resenting a restriction. That framing is accurate and it is also too modest, because it presents as damage limitation what is in substance the largest benefit the instrument delivers to the population.

Stated positively: **this is a technology-regulation instrument under which the regulated good becomes cheaper for the citizen.** That combination is unusual enough to be worth naming. Regulation of a new technology ordinarily raises its price, because compliance costs are passed forward. Redistribution ordinarily operates through the fiscal system, at one remove from the thing being distributed. Here the same structure does both at once, and the mechanism is not a subsidy bolted on but the property relation itself.

Three consequences follow and each is developed below. The price to the possessor falls. Access widens rather than narrowing, and can be widened deliberately for those least able to pay. And the timing of adoption determines whether the arrangement is experienced as a norm or as an imposition.

The state is the sole supplier, so it sets the terms. Where import for private sale is closed and the state is the channel, the price, the finance and the service package are policy variables rather than market outcomes. A state can offer the same model at less than the private market would charge.

Subsidy is affordable because the state holds the residual. A lessor with a reversion in a durable asset can price below the outright sale price without loss, because it retains the asset's remaining value. That is ordinary leasing economics and the reason the scheme can be cheaper for the possessor than purchase would have been.

Servicing should be included and mandatory. This is the point at which four objectives coincide, and the most elegant feature available. Mandatory free servicing is a consumer benefit, an inspection occasion, the enforcement mechanism for the modification rule—the same visit that maintains the unit verifies its configuration under §20.3—and, per §20.1, the doctrinal predicate on which the entitlement to inspect rests at all. Inspection stops being an intrusion the possessor tolerates and becomes a service they receive, and it stops being a bare right of entry and becomes the correlative of an obligation assumed.

And access widens rather than narrowing. Part VII §27 objects that rationing may reserve the technology to those who can afford it. Subsidised leasing with included servicing points the other way: the capital barrier to possession falls, because the possessor pays for use rather than for the asset. Whether the net effect is inclusive depends on the allocation rule at §19, and it is at least available, which it is not under a tax.

Modification reporting completes it, and there is a working model. A possessor should be required to report modification, as a motorist reports alteration to an insurer, on pain of losing cover and breaching the agreement. That model works because the reporting duty is enforced by a private party with an interest in accuracy rather than by an inspectorate alone. **Robotics insurance is the obvious analogue and its emergence should be anticipated in the design rather than accommodated afterwards:** an insurer pricing the risk of a modified unit is a second enforcement channel operating continuously and at no public cost.

20B.1 Distribution, which the instrument can do deliberately rather than incidentally

The price effect at §20B falls on everyone. It can be made to fall unevenly, on purpose, and this is the point at which the scheme stops being a safety instrument that happens to be cheap and becomes an access instrument.

Three levers are available and none requires anything the structure does not already contain.

The lease term can be lengthened for those who cannot meet a capital outlay, because a lessor holding the reversion is indifferent between a short lease at a high rate and a long one at a low rate, provided the residual is intact. That is ordinary leasing arithmetic. What it means for a household is the difference between a machine being unavailable and a machine being affordable monthly.

The outright price can be discounted by category. Where the state is the channel it may publish a lower schedule for classes it identifies — the elderly, disabled possessors acquiring assistance units, single-income households, households in regions the labour-market data identify as exposed. A tax cannot do this at all: a fiscal instrument reaches the machine, not the person, and a charge cannot be made negative for a category of purchaser without becoming a separate benefit administered by a separate department.

And the servicing obligation at Article 7 is worth most to the possessor who can least afford a repair. A free maintenance undertaking is a flat benefit in cash terms and a steeply progressive one in practice, because the household for which an unexpected repair bill is a crisis is not the household buying its sixth unit.

The distributive claim should be put no higher than the evidence allows. Whether the net effect is inclusive depends on the allocation rule at §19 and on numbers this paper does not have. **What can be said is that the levers exist, that they are internal to the instrument rather than bolted on, and that no fiscal alternative has any of them.** The affordability objection at Part VII §27 runs the other way here; this section is the answer, and the graduated design at §19.1A is the other half of it, because a household entitlement held as of right cannot be outbid.

20B.2 Timing, and the difference between a norm and an imposition

An instrument of this kind is experienced very differently according to when it arrives, and the difference is not about persuasion.

The comparison worth making is with general-purpose computing. Within a single working life it moved from a specialist instrument, to a household appliance, to an assumed condition of ordinary life — and the

transition was not perceived as a transition while it was happening. Nobody experienced the arrival of the domestic computer as an event requiring consent. The terms on which computers were held were settled early, by accident and by market practice rather than by design, and they have proved almost impossible to revisit since.

Robotic systems are at the beginning of the same curve. Two things follow.

A property arrangement legislated before the installed base exists is a condition of acquisition rather than an interference with ownership. Nobody is asked to give anything up. A purchaser encounters the terms as the terms on which the thing is available, in the same way a purchaser encounters the fact that a vehicle must be registered and a firearm certificated. **The same arrangement legislated after twenty million units are owned outright is a confiscation of an expectation,** and would rightly be resisted as one.

And an arrangement adopted early becomes invisible, which is the condition under which it actually works. The instrument's three capabilities all depend on near-universal coverage: a quantity is nominal if a large stock sits outside it, an inspection regime that reaches half the units detects nothing reliable, and a reserve that can be called on only from recent purchasers is not a reserve. Coverage is a function of how early the rule attaches, and of nothing else.

This is the same point the paper makes at Part VII §26 about prospectivity, arriving from the direction of political feasibility rather than legal necessity. **The window is not open indefinitely and it does not close with an announcement.** It closes by accumulation, one purchase at a time, and a state that waits until the question is salient will find it has already been answered.

20B.3 What numbers buy, and a case that is on the record rather than imagined

The reserve at §20A is usually described in the abstract. It is worth being concrete, because the concrete version is more modest in one respect and far larger in another than the abstraction suggests.

Rescue robots were deployed at the World Trade Center site, and that deployment is the founding event of the discipline. The Center for Robot-Assisted Search and Rescue responded within six hours of the attacks of 11 September 2001, in what is the first known use of robots for urban search and rescue. Four teams took part — two robot manufacturers, a United States Navy centre, and one university group, which was on site from 12 to 21 September.³⁴

Set that beside the scale of the operation it joined. An estimated forty thousand people worked at the site and at the Staten Island landfill, the recovery ran until 30 May 2002 — some eight and a half months — and more than ninety thousand rescue, recovery and clean-up workers and volunteers were exposed to the site's environmental hazards.³⁵ The health programme established for those exposed had enrolled more than a hundred and twenty-five thousand members by 2024.³⁶

The constraint in 2001 was never the concept. It was the number of machines that four teams could physically bring to Manhattan. The idea worked well enough to found a field; there was simply

³⁴The Center for Robot-Assisted Search and Rescue responded within six hours of the attacks of 11 September 2001, in what is recorded as the first known use of robots for urban search and rescue. Four teams participated: Foster-Miller and iRobot, the United States Navy's Space and Naval Warfare Systems Center, and the University of South Florida, whose team was on site from 12 to 21 September collecting and archiving data on robot use. See the contemporaneous account in Robin R Murphy, 'Activities of the Rescue Robots at the World Trade Center from 11–21 September 2001' (2004) 11 *IEEE Robotics & Automation Magazine* 50; and Robin R Murphy, *Disaster Robotics* (MIT Press 2014).

³⁵An estimated 10,000 Fire Department of New York personnel and 30,000 other workers and volunteers took part in the rescue and recovery effort, at the site and at related locations including the Staten Island landfill: Centers for Disease Control and Prevention, 'Physical Health Status of World Trade Center Rescue and Recovery Workers and Volunteers—New York City, July 2002–August 2004' (2004) 53 *Morbidity and Mortality Weekly Report* 807 <https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5335a1.htm> accessed 16 October 2026. The recovery operation officially ended on 30 May 2002: National September 11 Memorial and Museum, '9/11 FAQs' <https://www.911memorial.org/911-faqs> accessed 16 October 2026. The figure of more than 91,000 rescue, recovery and clean-up workers and volunteers exposed to environmental hazards at the site and at related locations is that published by the New York City 9/11 Health programme.

³⁶World Trade Center Health Program, *Program at a Glance* (as of 31 March 2024) <https://www.cdc.gov/wtc/pdfs/statistics/paag20240331-P.pdf> accessed 16 October 2026, recording 125,633 members in total, of whom 6,897 had died of any cause. The figure is used here only for the scale of exposure and not as a causal claim about any individual condition.

nothing to scale it with, because no mechanism existed by which a state could call on machines it did not own.

That is precisely the gap the retained interest fills, and stating it this way disciplines the claim in both directions.

It is more modest than the abstraction suggests, because a domestic robotic system is not a void-penetration robot. Searching a collapsed structure requires small tracked or serpentine platforms designed for the task, and no quantity of general-purpose household machines substitutes for them. Anyone who claimed otherwise would be wrong on the engineering before they were wrong on the law.

And it is far larger than the abstraction suggests, because the void search was never where the eight and a half months went. The months went into carriage, lifting, cutting, lighting, debris movement, transport and the sheer sustained physical labour of forty thousand people working a site for the better part of a year. Those are the tasks a general-purpose machine can take, and they are the tasks that put ninety thousand people in contact with the hazards that later filled a health programme.

Every hour a machine spends on a site of that kind is an hour a person does not. That is the argument in its strongest and most defensible form: not that robots would have found more survivors, which cannot be shown, but that a reserve of machines callable at scale converts a portion of an eight-month human exposure into a machine exposure — and the exposure, not the search, is what the record shows the lasting cost to have been.

A state deciding whether this instrument is worth the constitutional difficulty should weigh it against that, rather than against the abstraction of a “civil reserve.”

20C. The defence limb, which this paper has so far implied rather than stated

§20A described recall in an emergency and listed armed attack among the triggers. That is not a civil-contingency scheme with a defence footnote. It is, in part, a defence scheme, and a paper that left the reader to infer it from a list would be concealing its own most consequential feature. This section states it, prices it, bounds what it can actually deliver, and §20D then deals with the legal consequence, which is severe and which nothing else in this paper prepares the reader for.

20C.1 What the mechanism is, stated without euphemism

A state operating the supply channel at §20B sets the price at which robotic systems reach possessors. It can set that price below what a private market would charge, because it retains the residual and because it buys at a scale no individual purchaser approaches. Cheap machines are acquired in large numbers by people who want them for their own reasons.

Every one of those machines is then a unit the state may recall on a term reserved before anyone entered the agreement.

The consequence is that private consumption expenditure has been converted into a contingent state capability, and the conversion is paid for by the possessor. In an emergency in which a state would ordinarily mobilise, it can also call in robotic capability from the general population: for carriage over damaged ground, casualty movement, clearance, contaminated-space work and area monitoring, and — because these are general-purpose machines under software control — for tasks their possessors never contemplated.

That is a defence argument. It should be made in the text rather than left to be discovered.

20C.2 The precedents are not exotic, and both are older than the technology

Two arrangements do substantially this already and neither is controversial.

The United States Civil Reserve Air Fleet. Established under a joint agreement between the Departments of Defense and Commerce in December 1951, after the Berlin Airlift, in which civilian carriers

had flown alongside military aircraft, as a federal emergency airlift capability. Privately owned commercial aircraft are contractually pledged to augment military airlift; on activation a carrier must have aircraft and qualified aircrews ready within twenty-four to seventy-two hours depending on the stage. It has been activated for Desert Shield and Desert Storm in 1990–91, for Iraqi Freedom in 2003, and for the evacuation from Afghanistan in 2021.³⁷

Ships taken up from trade. For the Falklands campaign in 1982 the United Kingdom took up forty-five merchant ships from trade — tankers, cargo and roll-on roll-off ships, offshore support vessels, tugs, ferries and passenger liners including *Canberra* and *Queen Elizabeth 2* — to support a logistics chain of some eight thousand miles.³⁸

Both are the same idea: a state obtaining, at need, physical capability that private parties have bought and maintained for their own commercial purposes. The retained interest differs from them in two respects and both favour it. The commitment is a term of the agreement under which possession was taken rather than a contract negotiated separately with each holder, so there is nothing to agree in the emergency. And the holder is a household rather than a carrier or a shipping line, which multiplies the number of units by several orders of magnitude and removes the negotiation entirely.

20C.3 What it costs the treasury, and why the arithmetic favours it

The comparison is not between subsidy and nothing. It is between subsidy and procurement.

A state procuring the same capability directly bears the unit cost, the cost of storage, the cost of maintaining machines that are not being used, the cost of the obsolescence of stored equipment, and the opportunity cost of capital tied up in idle assets. A state subsidising possession bears the subsidy, less the residual value it retains, and bears none of the other four, each of which is a cost of idleness. **It does bear the servicing it undertakes at Article 7, but on machines that are in use.**

Three further terms reduce the figure and they are worth naming because a defence ministry will ask.

Monopsony. A single national channel purchasing on published terms buys at a price no individual purchaser obtains. That is the ordinary effect of concentrated purchasing and it is the same reason a health service pays less for a drug than a pharmacy does.

The residual. A lessor retaining the reversion in a durable asset can price below outright sale without loss, because it keeps the asset's remaining value. That is ordinary leasing economics and it is what makes the subsidy cheaper than it looks.

And the maintenance obligation at Article 7 is not only a cost. The state undertakes to keep the units in repair, which is an expense — but it is also what keeps the contingent capability serviceable, and a directly procured reserve would incur the same expense with no possessor deriving any benefit from it in the meantime.

³⁷Theodore J Crackel, *A History of the Civil Reserve Air Fleet* (Air Force History and Museums Program 1998) ix, recording the programme's formal approval on 15 December 1951 by a memorandum of understanding between the Departments of Commerce and Defense; Michael H Cecire and Heidi M Peters, *Afghanistan Evacuation: The Civil Reserve Air Fleet (CRAF) and the Defense Production Act (DPA)* (Congressional Research Service Insight IN11731, 25 August 2021), on the Berlin Airlift and the federal emergency airlift capability created after it, and on the activations of 1990–91 and of August 2021, the third, for the evacuation from Afghanistan; Gerry J Gilmore, 'DOD activates commercial airlift reserves' (American Forces Press Service, 10 February 2003) <https://www.af.mil/News/Article-Display/Article/140014/dod-activates-commercial-airlift-reserves> accessed 16 October 2026, on the activation of Stage I in February 2003; and Air Mobility Command, 'Civil Reserve Air Fleet' (fact sheet) <https://www.amc.af.mil/About-Us/Fact-Sheets/Display/Article/144025/civil-reserve-air-fleet/> accessed 16 October 2026, on the contractual pledge of aircraft and on readiness within twenty-four to seventy-two hours of tasking according to the stage activated.

³⁸*The Falklands Campaign: The Lessons* (Cmnd 8758, 1982) paras 106 and 246 and Annex A, Table 5 ('Ships taken up from trade'), which lists forty-five merchant ships, among them the liners *Canberra* and *Queen Elizabeth 2*; para 107 places the Falkland Islands 8,000 miles from the United Kingdom. The White Paper is reproduced in Cabinet paper C(82) 43 (13 December 1982) <https://archive.margaretthatcher.org/doc03/821213%20C%2882%29%2043%20%28129-215-393%29.pdf> accessed 16 October 2026. The contemporary records are held at the National Archives under 'Operation Corporate, Falklands Conflict: ships taken up from trade (STUFT)'.

The direction of the comparison follows from the cost categories listed. This paper does not model the magnitudes, and a defence ministry considering the scheme would have to.

20C.4 What converted civilian machines can and cannot do, stated honestly

The temptation is to describe the reserve as an army. It is not, and overstating it would invite the correct objection that a domestic robot is not a military platform.

What is missing from a civil unit is ruggedisation to military standards, resistance to electronic attack, communications security, the energy architecture a contested emplacement demands, and any design assumption that an adversary is actively trying to defeat it. The companion engineering paper works through why a platform built for one mission is poorly specified for another: fielded ground robots are specified in payload and range, which are mobility quantities, and say nothing about what a platform can do while stationary or under jamming.³⁹

What survives conversion is the logistics case, and that is not a consolation prize. Ukraine's stated objective is that all frontline logistics be performed by robotic systems; its Defence Minister announced in April 2026 that twenty-five thousand ground vehicles would be contracted in the first half of the year, after more than nine thousand missions in March alone.⁴⁰ The first reported capture of a position by unmanned platforms alone, in Kharkiv Oblast in the summer of 2025, used purpose-built systems and was an assault rather than a hold.⁴¹ **Armies break at their logistics before they break at their front**, and a state that can call in tens of thousands of load-carrying, casualty-moving, clearance-capable machines has obtained the thing that is hardest to surge and least glamorous to fund.

The honest summary is that the reserve is a **support and sustainment** capability of very large scale, not a combat capability, and any planning assumption that treated it otherwise would be wrong for engineering reasons before it was wrong for legal ones.

20D. The consequence nobody has costed: recall makes civilian objects targetable

This is the most serious objection in the paper and it arises only because §20C states the defence limb plainly. Had the limb been left implicit the problem would have been left undiscovered, which is the strongest argument for stating it.

20D.1 The rule

Military objectives are limited to objects which **by their nature, location, purpose or use** make an effective contribution to military action and whose total or partial destruction, capture or neutralisation, in the circumstances ruling at the time, offers a definite military advantage.⁴² "Use" is present use. **"Purpose" is understood as intended future use**, and that is the word that does the damage here.⁴³

³⁹Christopher I V Farmer, 'Holding Ground with Machines That Do Not Move: Why Endurance Is the Wrong Measure for Terrain Denial, and What a Thirty-Day Armed Emplacement Actually Costs in Watt-Hours' (preprint, version 1.0.0, 6 August 2026) section 17.1, since revised as 'The Emplaced Machine: Energy, Detection, Recall and Control in Closed Ground-Denial Systems' (preprint, version 2.12.5, 17 October 2026) section 16.1 <https://civfarmer.github.io/publications/manuscripts/the-emplaced-machine-v2.12.5.pdf>, <https://doi.org/10.5281/zenodo.23073940>.

⁴⁰Katie Livingstone, 'Ukraine to field 25,000 ground robots in push to replace soldiers for frontline logistics' *Defense News* (24 April 2026) <https://www.defensenews.com/unmanned/2026/04/24/ukraine-to-field-25000-ground-robots-in-push-to-replace-soldiers-for-frontline-logistics/> accessed 16 October 2026, reporting statements by the Defence Minister, Mykhailo Fedorov, including his post of 18 April 2026 on the March missions.

⁴¹ibid, reporting the President's address of 14 April 2026, which described the operation, by the robotic strike unit of the 3rd Separate Assault Brigade using aerial drones and unmanned ground vehicles only, as the first capture of an enemy position by unmanned platforms alone in the war.

⁴²Protocol Additional to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (Protocol I) (adopted 8 June 1977, entered into force 7 December 1978) 1125 UNTS 3, art 52(2).

⁴³Yves Sandoz, Christophe Swinarski and Bruno Zimmermann (eds), *Commentary on the Additional Protocols of 8 June 1977 to the Geneva Conventions of 12 August 1949* (ICRC and Martinus Nijhoff 1987) para 2022: "The criterion of purpose is concerned with the intended future use of an object, while that of use is concerned with its present function." The reading is not advanced as novel, and it is not the widest in state practice: the United States Department of Defense *Law of War Manual* (June 2015, updated July 2023) section 5.6.6.1 uses the phrase "intended or possible use in the future", as noted

20D.2 The two readings, and why the second is available

On the first reading, conversion happens at recall. A domestic robot doing domestic work makes no contribution to military action. It becomes a military objective when it is recalled and used, and not before. On that reading the scheme creates no standing liability and the design is unremarkable.

On the second reading, the reservation is itself the purpose. A statute providing that every unit of a designated class is subject to recall for defence tasks in a declared emergency has stated an intended future use, in advance, for every unit in the class. If that intended use would make an effective contribution to military action, then the object's "purpose" satisfies the definition **before any recall occurs**.

The second reading is not strained. It is the ordinary meaning of the word, applied to a statutory reservation that is public, general and permanent.

The consequence, if it is right, is that a scheme intended to make households safer has made several million of them a targeting question. The unit sits in a dwelling. A dwelling is presumed civilian in case of doubt,⁴⁴ and that presumption is real protection — but a presumption operates where there is doubt, and a published statute reserving the contents of the dwelling for defence use is not a source of doubt. It is a source of certainty in the wrong direction.

Two further provisions then engage and both cut against the scheme as drafted. A party may not use the presence of civilians to render points immune from military operations or to shield military objectives. And a party must to the maximum extent feasible endeavour to remove civilian objects from the vicinity of military objectives and avoid locating military objectives within or near densely populated areas.⁴⁵ **A scheme that deliberately distributes a contingent military reserve across the residential building stock is in tension with the second of those and can be argued into the first.**

20D.3 What the design has to do about it

Four changes follow and the first is the load-bearing one.

The reserved tasks must be confined to those which do not make an effective contribution to military action. Carriage of humanitarian supplies, casualty movement, debris clearance, decontamination and monitoring for civil-protection purposes are civil-defence functions. Carriage of munitions, engineering in support of operations, and the mounting or operation of weapons are not. **The instrument should list the permitted tasks exhaustively and should not include the second class**, because the moment it does, every unit in the country acquires a military purpose.

A state that wants the second class must obtain it differently. Nothing in this paper prevents a state from designating a separate class of system, held under a separate agreement, by holders who are not domestic households, kept at locations that are not dwellings, and identified as what they are. That is the Civil Reserve Air Fleet model, and it works precisely because the aircraft sit at airports rather than in living rooms. **The mistake would be to obtain combat capability by the household route because the household route is cheaper.**

The reservation must be drafted as a civil-contingency power in which defence is one listed emergency, not as a standing military assignment. The difference is not presentational: the first is a contingent administrative power over a chattel, and the second is a declared intended use. Article 7A is drafted the first way, and §20D.4 sets out what no drafting removes.

And recall must be to a designated authority and to a stated location before any use. A unit that has been recalled, removed from the dwelling and placed under public control has been converted openly.

in Mark Lattimer, 'Dual-Use Objects and Dual-Purpose Attacks' (*Articles of War*, Lieber Institute, 18 May 2026) <https://lieber.westpoint.edu/dual-use-objects-dual-purpose-attacks/> accessed 16 October 2026. Whether a power exercisable only on a declared emergency is an intended use at all is the open point conceded at Part I §4.3. What is advanced as novel is the application of the definition to a standing statutory reservation over privately possessed chattels, which so far as the author can establish has not been considered.

⁴⁴Protocol I (n 42), art 52(3), under which an object normally dedicated to civilian purposes—a place of worship, a house or other dwelling, or a school—is presumed not to be making an effective contribution to military action in case of doubt.

⁴⁵ibid, arts 51(7) and 58(a)–(b).

A unit used in situ has converted the dwelling with it.

The first change has treaty text behind it. Article 61(a) of Protocol I defines civil defence by a list of humanitarian tasks — among them warning, evacuation, rescue, medical services, fire-fighting, the detection and marking of danger areas, decontamination, the provision of emergency accommodation and supplies, and the emergency repair of indispensable public utilities — and the uses permitted by Article 7A track that list closely. Buildings and matériel used for civil defence purposes are covered by Article 52, and objects so used may not be destroyed or diverted from their proper use except by the Party to which they belong; and the performance of civil defence tasks under the direction or control of military authorities is not an act harmful to the enemy which would end the protection.⁴⁶ The limit has to be stated with the point. The Protocol's chapter on civil defence builds its protection around civilian civil defence organisations, and Article 61(b) confines those to bodies organised or authorised by the competent authorities and assigned and devoted exclusively to such tasks. The designated authority's recall arm would therefore have to be constituted as one, and a recalled unit devoted to those tasks alone for as long as the recall lasted.

20D.4 What cannot be drafted away

No formulation removes the argument entirely, and it would be dishonest to suggest otherwise.

A belligerent minded to argue that a state has distributed a military reserve across its residential building stock will make that argument whatever the statute says about permitted tasks, because the machines are general-purpose and under software control and the state holds title to all of them. **The counter-argument is available — that the permitted tasks are civil-defence functions, that conversion to any other use would be a breach of the state's own instrument, and that an object's purpose is what it is lawfully reserved for rather than what it could be made to do — but it is a counter-argument and not an answer.**

The honest position is this. The defence value of the scheme is real, it is largely a logistics value, and it is obtained at a fraction of procurement cost. **The price is that the state has created a category of civilian object about which an adversary can construct a colourable targeting argument, and the mitigation is a drafting discipline rather than a guarantee.** A state that would not accept that trade should adopt the scheme without the recall provision, which leaves the quantity and inspection capabilities intact and forgoes the third.

21. Why the capabilities have to come together

The paper's claim is that the retained interest supplies all three, and it should be stated why they are not separable in the way one might expect. Quantity control and access were the original pair; recall at §20A was found rather than designed, and it turns out to depend on the same structure.

Quantity control without access is unenforceable at the margin. A regime that limits the number of units but cannot examine them cannot detect a unit that has been modified to do the work of several, nor one operating outside the terms on which its lease was granted. The quantity is then nominal. The graduated form at §19.1A depends on this more heavily than the flat form would, because a threshold defined by use at a site is defeated by structuring unless somebody can go and look.

Access without quantity control addresses only the modification problem, and leaves the displacement problem to the fiscal instruments Part III says cannot solve it.

Recall requires the reversion and nothing else supplies it. A licensing regime with an inspection power could requisition only by expropriating, because a licensee owns the thing. §20A's whole argument is that the state is recovering its own chattel, and that argument is unavailable to any structure in which title has passed.

And all three require the same thing: something that persists into the operating life. That is the observation at §1, and the retained interest is the least invasive structure the author can identify which

⁴⁶Protocol I (n 42), arts 61(a)–(b), 62(3) and 65(1)–(2)(a).

supplies it. A licence would supply the quantity control and would carry no natural inspection right and no recall. A registration scheme would supply none of them. A property interest supplies all three because it is a relationship rather than an event, and the whole difficulty with the existing instruments is that they are events.

Part VI—Airworthiness as the Precedent

22. Why this analogy and not the others

Several existing regimes combine private holding with continuing state involvement, and it is worth saying why airworthiness is the one worked out here rather than the more obvious comparators.

Vehicle registration and periodic testing supply continuing inspection but no quantity control and no retained property interest; a roadworthiness test is a condition of use rather than an incident of ownership.

Goods-vehicle operator licensing is closer than either, and Part V §19.1A takes the graduated structure from it: private use engages nothing, business use requires a licence specifying a maximum number of vehicles, and the vehicles are tied to a stated operating centre.⁴⁷ What it lacks is the retained property interest, which is why it can control quantity and place but not configuration.

Firearms certification supplies quantity control and a conditional entitlement, and is the closest on that axis. It is a poor model for the other, because the object is simple, unmodifiable in the relevant sense, and inspected principally for its existence and storage rather than for its internal configuration.

Spectrum licensing supplies quantity control over a resource the state indisputably holds, which is why it works and why it does not transfer: nobody argues the state owns machines as it owns the spectrum.

Airworthiness supplies all three at once—private ownership, continuing state access to the specific unit, and compulsory post-sale modification control—over a complex object whose internal configuration is what matters, operated by private persons, at scale, with a functioning inspectorate. That combination is what this paper’s proposal requires and the reason airworthiness is treated at length.

23. The four transferable features

The certificate is continuing and conditional. An aircraft holds a certificate of airworthiness which is not a one-time approval but a continuing status, maintained against a maintenance programme, periodically reviewed and certified, and capable of lapsing.⁴⁸ That is the structural analogue of a renewable lease: the entitlement to operate persists only while conditions are met.

Inspection is periodic and mandatory, not triggered by suspicion.⁴⁹ Aircraft are inspected on a schedule regardless of whether anything is thought to be wrong. That matters for this paper’s proposal because it answers a question the modification problem otherwise raises acutely: what grounds an inspection? Under a suspicion-based model, inspection requires cause and cause requires the very information the inspection would obtain. A schedule dissolves the circularity, and it does so without any inspection being an accusation.

Modification is controlled after sale, by directive.⁵⁰ Where a defect or hazard is identified after

⁴⁷Goods Vehicles (Licensing of Operators) Act 1995, ss 2(1), 5(4) and 6(1)(a); and see Part V §19.1A.

⁴⁸Commission Regulation (EU) No 1321/2014 of 26 November 2014 on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks [2014] OJ L362/1, Annex I (Part-M), under which continuing airworthiness is managed against a maintenance programme and the airworthiness review is conducted periodically and evidenced by a certificate, so that the aircraft’s status is maintained rather than granted once.

⁴⁹Continuing Airworthiness Regulation (n 48). The scheduled character of the airworthiness review is what dissolves the circularity described in the text: under a suspicion-based model an inspection requires cause, and cause requires the information the inspection would supply.

⁵⁰Commission Regulation (EU) No 748/2012 of 3 August 2012 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations [2012] OJ L224/1, Annex I (Part 21), point 21.A.3B, under which an airworthiness directive

aircraft have entered service, an airworthiness directive requires action by the operators of affected aircraft, and compliance is mandatory. This is the feature with no analogue anywhere in the robotics instruments at Part IV: **a mechanism by which a regulator reaches units already in private hands and requires something of them.** The robotic equivalent is direct—a directive requiring possessors of a given type to present units for a firmware correction—and it is impossible under any of the existing instruments because none of them establishes a relationship with the unit after sale.

And an inspectorate exists, at arm’s length, with a defined and limited remit.⁵¹ The regime is administered by a technical body whose function is confined to airworthiness. It is not a police power and does not become one, and its officers are not gathering information for any purpose beyond the certificate. Part V §20.3’s insistence on an independent body with a statutory bar on incidental disclosure is taken from this feature.

24. What the analogy gives that is not obvious

Two things worth drawing out, because they answer objections raised elsewhere in this paper.

It shows that intrusive continuing inspection of privately owned property is publicly acceptable where the rationale is legible. Aircraft owners do not generally regard the airworthiness regime as an intrusion on their property, and the reason is that the connection between the inspection and the harm is obvious to everyone including the owner. Part VII’s surveillance objection is partly answered by that observation: acceptability tracks the legibility of the rationale, and the rationale for inspecting a robotic system’s safety configuration is as legible as the rationale for inspecting an airframe.

And it shows the inspectorate model working without becoming a surveillance apparatus, over decades, at international scale. That is not proof it would hold in a different setting, but it is the strongest available evidence that a technical inspection right can be confined to its purpose, and the burden is fairly on whoever says it could not be.

25. Where the analogy fails, tested feature by feature

The analogy is only worth as much as its limits, and Part I §4.3 stated that it fails if its transferable features depend on aviation-specific conditions. Four candidates, taken at full strength.

Population and value. Aircraft are few and expensive; robotic systems on the scenario this paper contemplates would be many and comparatively cheap. An inspection regime whose unit cost is acceptable against an airframe may be prohibitive against a domestic machine.

Assessment: this is the strongest of the four and it is not fully answered. The partial answer is that attestation-based inspection under §20.3 is cheap by construction—it is a challenge and a comparison, capable of being performed remotely or at a service point rather than by an inspector attending premises—and that the expensive part of airworthiness is the physical examination of structure, which has no analogue here. But the claim that the model scales by three or four orders of magnitude is asserted rather than demonstrated, and a reader who doubts it has identified the proposal’s most vulnerable point.

Professional operators. Aircraft are operated by licensed people within an established safety culture. Robotic systems in the contemplated scenario would be possessed by the general public.

Assessment: real but less damaging than it appears. The regime does not depend on the operator’s expertise; it depends on the operator presenting the unit. Vehicle testing achieves that with an entirely lay population.

is a document mandating actions to restore an acceptable level of safety and is issued where an unsafe condition has been determined to exist and is likely to exist or develop in other aircraft. That is the feature with no analogue in any of the instruments considered at Part IV: a regulator’s power to require action in respect of units already in private hands, after sale, on the basis of a hazard identified later.

⁵¹Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency [2018] OJ L212/1, which establishes the Agency and confers its certification and oversight tasks. The institutional separation of the airworthiness function from police and security functions is the feature relied on at Part V §20.3 and again at Part VII §30.

Accident salience. Aviation accidents are rare, catastrophic and highly visible, which sustains public acceptance of intrusive regulation. Robotic injuries would be commoner, individually less dramatic, and less visible.

Assessment: this cuts against the proposal politically rather than structurally. It suggests such a regime is unlikely to be adopted before a salient incident, which is a prediction about politics and not an objection to the design.

And international harmonisation. Airworthiness works partly because it is internationally standardised, so that an aircraft is not subject to conflicting regimes.

Assessment: this is why Part IX drafts at Union level and Part VIII tests the instrument comparatively. A national robotics inspection regime would face precisely the arbitrage the aviation regime avoids by being harmonised, and that is an argument about the level at which the instrument must sit rather than about whether it can work.

Part VII—Objections

26. The property objection

The first objection is that the state cannot simply declare itself owner of a class of chattel, and that a scheme converting purchasers into lessees interferes with the peaceful enjoyment of possessions.⁵² The protection is not absolute: it permits a state to control the use of property in accordance with the general interest, which is the limb any scheme of this kind must satisfy.⁵³

Which limb applies is the whole of the argument, and the provision has long been read as containing three distinct rules rather than one: the general principle of peaceful enjoyment, a rule subjecting deprivation of possessions to conditions, and a rule preserving the state's entitlement to control the use of property in accordance with the general interest.⁵⁴ **This proposal is a control-of-use measure and not a deprivation, and the classification is not a lawyer's trick.** Nothing anyone owns is taken. What is regulated is the interest that may be acquired in a class of chattel not yet placed on the market, which is the same operation performed by every rule that says a thing may be held only on stated terms.

Three replies, and the second is the one that matters.

Prospectivity. The proposal operates on units placed on the market after commencement. It does not expropriate anything anyone already owns, and a person who buys a thing on stated terms after those terms are law has acquired what the law offered rather than lost what it did not.

The interference is with the form of the transaction, not with the possession. A purchaser under this scheme obtains exclusive possession, use, quiet enjoyment, and assignability—the substance of what a buyer wants—and does not obtain the reversion. The state's interference is with the ability to acquire a freehold interest in a particular class of machine, which is a lesser interference than the many existing restrictions on what may be owned outright and on what terms.

And the aim is legitimate and the means are connected to it. The objectives are labour-market adjustment and public safety; the means is a property structure supplying quantity control and inspection; and Parts III and IV establish that the less intrusive alternatives cannot deliver either. That is the shape a proportionality argument has to take, and this paper's position is that it is arguable rather than that it is unanswerable.

⁵²Protocol to the Convention for the Protection of Human Rights and Fundamental Freedoms (adopted 20 March 1952, entered into force 18 May 1954) ETS 9, art 1.

⁵³*ibid*, art 1, second paragraph, which preserves the right of a State to enforce such laws as it deems necessary to control the use of property in accordance with the general interest.

⁵⁴*Sporrong and Lönnroth v Sweden* App nos 7151/75 and 7152/75 (ECtHR, 23 September 1982), in which the plenary Court identified the three rules contained in art 1 of Protocol 1 and found violations as regards both applicants.

27. The distributive objection

The second objection is sharper and is not answered by proportionality. A rationed good is allocated somehow, and rationing robotic capital may entrench access rather than widening it: the wealthy obtain leases, the rest do not, and a technology which might have raised general productivity is reserved to those who can secure a licence.

The objection is sound against a uniform quantity and is largely answered by the graduated one.

Under the design at Part V §19.1A nothing at household scale is rationed. Possession up to the entitlement threshold is as of right: no application, no queue, no allocation rule and therefore no allocation. The objection reaches only the capped band, where it ceases to be an objection about who has access to the technology and becomes one about which undertakings may expand how fast—a real question, but a different and much smaller one. It is also worth stating the comparison plainly: **a tax reaches the household and this instrument does not**, so on the distributive question the fiscal alternative is the more regressive of the two.

Within the capped band, any allocation rule has a distributive consequence, and the paper does not have a costless one. Auction allocates by ability to pay. Administrative allocation invites capture. First-come allocates by information and access to process, which correlates with resources. Sectoral quotas embed a judgement about which industries matter.

What the paper claims is narrower: the distribution is happening either way, and an instrument that forces it to be stated is preferable to one that lets it happen silently. Under a tax the distribution is by ability to pay and is invisible. Under a licensing regime somebody must publish an allocation rule and defend it. That is not a solution to the distributive problem; it is a relocation of it into a forum where it can be argued about.

And essential-use priority is available in a way it is not under a price instrument. A licensing authority can prefer applications for care, disability assistance or hazardous work over applications for substitution in sectors where the labour-market consequence is severe. A tax cannot discriminate that way without a base so complex it becomes administratively unworkable.

28. The competence objection

The third objection is that an inspectorate capable of auditing millions of units is a substantial state capability which may simply not be buildable, and that a regime whose enforcement is nominal is worse than none because it confers false assurance.

Two replies and a concession.

Attestation-based inspection is designed for scale, per Part V §20.3. The inspection is a cryptographic challenge and a comparison, not a physical examination, and it can be performed at a service point, by an authorised third party, or remotely by the possessor presenting the unit. The expensive component of airworthiness has no analogue here.

And the inspectorate does not have to inspect everything. A statistically designed sampling regime, with a schedule for high-capability classes and sampling for the rest, is how most product-safety surveillance operates.

The concession is that this has not been demonstrated at the contemplated scale, and Part VI §25 identifies it as the proposal's most vulnerable point. A reader who thinks the scaling claim is wrong is disagreeing with the paper at the right place.

29. The evasion objection

The fourth objection is that a scheme in one jurisdiction is defeated by parallel import, self-build and arbitrage.

Parallel import is answerable by attaching the requirement to placing on the market and to possession within the jurisdiction, which is how product-safety law already operates and which the Union's market-surveillance architecture already enforces.⁵⁵

Self-build is answerable in part. A person assembling a machine from components is not caught by a market-entry rule and is caught by a possession rule, though enforcement against individuals is weak. The honest position is that a determined individual can build an uninspected machine, and the same is true of firearms in every jurisdiction that regulates them; the regime is aimed at the general population rather than at the determined.

Jurisdictional arbitrage is why Part IX drafts at Union level, and why Part VIII tests the instrument against the jurisdictions it must coexist with. A single-state scheme fails.

30. The surveillance objection, which is the hardest

The fifth objection is the one most likely to defeat the proposal and it is stated here at its strongest rather than in a form convenient to answer.

A right of access sufficient to inspect is a right of access sufficient to surveil. The proposal creates a lawful, routine, scheduled entitlement for a state body to interrogate a machine that lives in a private home, that has sensors, and that has been present for everything that happened there. Whatever the statute says the inspection is for, the capability exists, and capabilities are repurposed. The instrument that solves the modification problem creates a monitoring infrastructure of a kind no democracy has previously extended into the domestic interior.

The paper's answer is structural and it is offered as partial.

The attestation mechanism means the inspection yields one bit. Under Part V §20.3 the unit computes a cryptographic attestation of its software state and the inspector compares it against a published value. The inspector does not read the code, the logs or the data, and cannot: the protocol does not transmit them. An inspection regime built this way does not accumulate a capability to surveil, because at no point does it acquire access to anything from which anything about the household could be inferred.

The answer given at §20.3 bears restating in the form this objection demands. The scope operates as a jurisdictional bar, so an inspector who exceeds it has acted without power at all, and the consequence attaches to the evidence rather than to the inspector's conscience. What the objection is entitled to ask is whether such a bar holds under pressure, and the honest answer is that it survives exactly as long as the courts enforce it.

And the right is vested in an independent technical body with a statutory bar on incidental disclosure, on the airworthiness model, at arm's length from police and security functions.

A second surface has to be conceded, because Part V §19.1B created it. The application band is a data-collection power: applicants state intended use, place and number, and the authority accumulates a forward record of robotic deployment across the economy. That is a real capability and it is not answered by the attestation argument, which addresses inspection rather than registration. Three things bound it. The entitlement band means the great majority of possessors never make an application and never appear in the record at all. The record contains stated intentions about units, uses and places rather than anything a unit has observed. And Article 6 requires publication only in aggregated form and bars publication identifying an applicant. Those constraints are weaker than the ones protecting the inspection, and the paper does not pretend otherwise: a state that wanted a map of where automation was arriving would have one, and the argument for building it is that a state setting the cap in Article 6A needs exactly that map to set it defensibly.

What the paper cannot offer is an assurance that those limits hold under pressure. Statutes are amended, bodies are reorganised, and emergencies generate exceptions. The honest statement is that

⁵⁵Market Surveillance Regulation (n 25). The point in the text is about the reach of the existing architecture over goods entering the market, and is not inconsistent with Part IV §16: that architecture reaches products made available on the market and the economic operators who supply them, and does not reach the possessed unit.

this design makes surveillance harder than the obvious alternatives and does not make it impossible, and that a reader who regards any domestic inspection capability as unacceptable regardless of its design has a coherent position which this paper does not refute.

Part VIII—The Comparative Test

31. Why the instrument is drafted at Union level

Part VII §29 established that a single-state scheme fails to arbitrage. Two further reasons make the Union the right level.

The reference already exists there. The Machinery Regulation’s conformity assessment documents the approved configuration against which an attestation-based inspection compares, so the Union is the jurisdiction in which the technical predicate for §20.3 is already in place.⁵⁶

And the internal market supplies both the problem and the machinery. Free movement of goods makes a national scheme leaky and Union-level harmonisation makes it tight, which is the same reason product safety is regulated at that level already.

32. International trade law

The scheme must be tested against the trade rules, because a requirement that machines be leased rather than sold is capable of operating as a restriction.

National treatment. A retained-interest scheme applying equally to units of domestic and foreign origin is facially origin-neutral.⁵⁷ That is not the end of it, because the obligation is one of result rather than of form: formally identical treatment may still afford less favourable treatment where it modifies the conditions of competition to the detriment of the imported product, which is how the Appellate Body approached a measure that confined imported beef to separate retail outlets.⁵⁸ The exposure here is therefore to a *de facto* argument: if the scheme’s practical effect is to advantage domestic manufacturers—because they are closer to the approval process, or because the attestation infrastructure favours incumbents—that is where a challenge would be brought, and the answer must be in the design of the approval and attestation arrangements rather than in the property structure.

Quantitative restrictions. This is the sharper exposure and it should not be minimised.⁵⁹ A licensing regime capping the number of units in circulation restricts the quantity that can be sold into the market, and the fact that the restriction operates through a property structure rather than through a quota at the border does not obviously save it. The defence must be that the measure is a regulation of the conditions of possession and use applying to all units however sourced, and that any trade effect is incidental to a legitimate objective. If that fails the measure must be justified under the general exceptions, where “necessary” is assessed by weighing the contribution the measure makes to its objective, the importance of the objective, and the trade-restrictiveness of the measure, and where a reasonably available less restrictive alternative defeats the defence.⁶⁰ Parts III and IV are, on that framing, the necessity argument: they are an attempt to show that the less restrictive alternatives do not achieve the objective.

One feature of that jurisprudence cuts against this paper and should be stated rather than left for a critic to find. **Proposed alternatives are assessed not only one by one but also together:** in *Brazil*—

⁵⁶Machinery Regulation (n 2), and Part IV §17.

⁵⁷General Agreement on Tariffs and Trade 1994, art III, on national treatment on internal taxation and regulation.

⁵⁸*Korea—Measures Affecting Imports of Fresh, Chilled and Frozen Beef*, WT/DS161/AB/R, WT/DS169/AB/R (Report of the Appellate Body, circulated 11 December 2000), holding that formally different treatment is not necessarily less favourable and that the question is whether the measure modifies the conditions of competition to the detriment of the imported product—there, by cutting imported beef off from the normal retail outlets.

⁵⁹General Agreement on Tariffs and Trade 1994 (n 57), art XI, on the general elimination of quantitative restrictions; and art XX, on general exceptions, which is where a justification would have to be located.

⁶⁰*Korea—Beef* (n 58) para 164, on the weighing and balancing by which necessity is assessed; and *Brazil—Measures Affecting Imports of Retreaded Tyres*, WT/DS332/AB/R (Report of the Appellate Body, circulated 3 December 2007), applying that approach under art XX(b) and upholding the finding that the import ban was provisionally justified as necessary.

Retreaded Tyres the Panel found that none of the measures proposed by the European Communities, “either individually or collectively”, would achieve Brazil’s objective, and the Appellate Body, rejecting the complaint that the Panel had failed to make a collective assessment, relied on that finding in upholding the necessity of the import ban.⁶¹ The obvious combination here is a robot tax together with a separate statutory power of inspection. Parts III and IV argue that the second would have to be justified from first principles and would be politically and doctrinally harder; they do not argue that it is impossible, and the Appellate Body treats an alternative as not reasonably available where it is merely theoretical or would impose an undue burden, such as prohibitive costs or substantial technical difficulties, so on this jurisprudence “harder” may not be enough.⁶² A reader who thinks the combination is reasonably available has identified the point at which the trade-law defence of this instrument is weakest.

State trading, which §20B makes unavoidable. The consent design at Part V §20B requires the state to be the channel through which units reach possessors, and a state trading enterprise enjoying exclusive import or distribution rights is squarely within the trade disciplines.⁶³

The exposure is real and is smaller than it first appears, and the reason is a point of interpretation that a reader coming to the provision cold would miss. The requirement that such an enterprise act in accordance with commercial considerations, and afford other parties adequate opportunity to compete, is not a free-standing obligation to behave commercially. **The Appellate Body has held that the second subparagraph does not contain a separate obligation but defines the non-discrimination obligation in the first**, so that the discipline is a discipline against discriminatory conduct rather than a general prohibition on state channels behaving non-commercially.⁶⁴ That matters here, because a state channel purchasing from all manufacturers on published, non-discriminatory terms is complying with a non-discrimination obligation rather than defending the commercial rationality of a subsidy it has deliberately chosen to pay.

Two further things narrow it. The exclusivity is over distribution to possessors rather than over manufacture or import for other purposes. And the subsidised element is a transfer to possessors rather than a preference between suppliers, which is where the discipline bites.

The residual exposure is that a state channel is a monopsony, and a monopsony purchasing on published terms still sets those terms. Nothing in the interpretation above prevents terms that in practice only domestic manufacturers can meet, and that is where a well-advised complainant would go. A reader for whom the discipline nonetheless defeats the supply monopoly should read Part V §20B as an argument for subsidised leasing *alongside* private sale rather than instead of it—which weakens the black-market answer, because a lawful private purchase route reintroduces the possibility of an unleased unit, and the paper has no answer to that beyond making the leased route more attractive.

Technical barriers. An attestation requirement is a technical regulation and would need to be justified as no more trade-restrictive than necessary. That is the ordinary discipline and the answer is the ordinary one: the objectives are safety and labour-market adjustment, and Parts III and IV establish that less restrictive instruments do not achieve them.

33. The United Kingdom

The United Kingdom is the natural control case, for two reasons.

It has the closest analogues already operating. Firearms certification, vehicle type approval and

⁶¹*Brazil—Retreaded Tyres* (n 60) paras 180–183, quoting Panel Report, *Brazil—Measures Affecting Imports of Retreaded Tyres*, WT/DS332/R (circulated 12 June 2007) para 7.214. The Appellate Body did not hold that a panel errs by examining alternatives individually; it held that the Panel had not erred, in part because the Panel had also examined them collectively.

⁶²*Brazil—Retreaded Tyres* (n 60) para 156, quoting *United States—Measures Affecting the Cross-Border Supply of Gambling and Betting Services*, WT/DS285/AB/R (Report of the Appellate Body, adopted 20 April 2005) para 308.

⁶³General Agreement on Tariffs and Trade 1994, art XVII, on state trading enterprises and the requirement that they act in accordance with commercial considerations and afford adequate opportunity to compete.

⁶⁴*Canada—Measures Relating to Exports of Wheat and Treatment of Imported Grain*, WT/DS276/AB/R (Report of the Appellate Body, circulated 30 August 2004), holding that art XVII:1(a) is the general and principal provision and that subparagraph (b) does not impose a separate obligation but defines the non-discrimination obligation in (a).

testing, and an airworthiness regime inherited from and now separated from the Union system. A retained-interest scheme would be built on institutions that exist rather than institutions that would have to be created.

And it faces the arbitrage problem immediately. A Union scheme and a divergent United Kingdom would create precisely the differential that Part VII §29 identifies as fatal, across a border with substantial goods movement. The practical question for the United Kingdom is therefore not whether the scheme is desirable in the abstract but whether divergence is sustainable, and the answer for product regulation has generally been that it is not.

34. The United States

The hardest constitutional environment, and therefore the most useful test.

Takings. A scheme converting purchasers into lessees prospectively does not take existing property, but it restricts the interest that may be acquired, and a challenge would test whether that restriction goes too far. The prospectivity point at Part VII §26 is the principal answer and it is stronger in this context than in the Convention context, because the objection is to acquisition rather than to deprivation.

Federal competence. A federal scheme would rest on the commerce power, and its application to intrastate possession of a unit manufactured intrastate is the classic difficulty.

And preemption across state property law. Property is a matter of state law, and a federal instrument creating a novel retained interest in chattels would sit awkwardly across fifty regimes. A state-by-state approach reintroduces arbitrage within the internal market.

The honest assessment is that the instrument is hard in the United States and that this paper has not solved it. If the analysis is right, the proposal is regional rather than general, and that should be stated rather than obscured.

35. Asia

Three groupings and they are differently placed.

Japan and South Korea have the deepest robotic deployment in manufacturing and eldercare and therefore the most immediate exposure to both problems. Both have strong property protections and developed product-safety regimes, and both would face the constitutional and practical difficulties in a milder form than the United States.

Singapore is the jurisdiction most likely to adopt something of this kind first: small, administratively capable, comfortable with licensing instruments, and with a policy tradition of regulating quantity directly where it judges quantity to be the problem. A pilot there would generate the operational evidence Part VI §25 says is missing.

And China is the case that has to be confronted rather than mentioned. It is the largest producer, it is the state most capable of implementing a retained-interest scheme, and it faces none of the property-law obstacles that make the instrument difficult elsewhere. A state which can direct the terms on which chattels are held, and which already operates extensive registration and inspection infrastructure, could implement this proposal considerably more easily than any state examined above.

36. The uncomfortable conclusion

That last observation generalises, and the generalisation is a serious objection to the paper's own proposal.

A retained-interest scheme is easiest to implement in states with weak protections for private property and hardest in states with strong ones. The features that make the instrument work—a state able to define the terms on which things are held, an inspectorate with routine access to private premises, a licensing authority setting quantities—are features that liberal constitutional orders have deliberately made difficult to assemble.

Three responses, and none of them fully answers it.

The instrument’s difficulty in liberal states is a feature of those states working correctly, not a defect of the states. An objection that a proposal is hard to implement where power is constrained is partly a compliment to the constraints.

The design choices at Part V §20 are aimed precisely at this. Attestation rather than extraction, jurisdictional rather than instructional limits, and an independent body rather than the executive are all attempts to build an instrument that a liberal order could adopt without acquiring a capability it would regret. Whether they suffice is the question at Part VII §30 and the answer given there is partial.

And the alternative is not the absence of the instrument but the absence of the capability. If liberal states cannot adopt a scheme of this kind, they will address displacement fiscally and modification not at all, while states unencumbered by these constraints will do both. That is a worse outcome than an imperfect instrument, and the strongest argument the paper has for pressing on with a proposal whose difficulties it concedes.

What the paper does not claim is to have designed an instrument that is as easy for a liberal state as for an illiberal one. It has not, the asymmetry is real, and a reader who regards it as decisive has identified the objection the author found hardest to answer.

Part IX—The Instrument, Drafted

37. Form and level

Drafted as a Regulation, at Union level, for the reasons at Part VIII §31: the technical reference already exists in the machinery conformity assessment, the internal market supplies both the arbitrage problem and the machinery to answer it, and a national scheme fails.

It is drafted to sit alongside the Machinery Regulation rather than to amend it, because the two do different things: the Machinery Regulation governs placing on the market and this instrument governs possession thereafter.

Regulation on the possession of regulated robotic systems (proposed)

Article 1—Scope. This Regulation applies to regulated robotic systems placed on the market after its date of application. It does not apply to systems placed on the market before that date.

Article 2—Definitions. For the purposes of this Regulation—

- (a) “regulated robotic system” means machinery within the meaning of Regulation (EU) 2023/1230 which is capable of autonomous physical action in an unstructured environment and which falls within a class designated under Article 3;
- (b) “possessor” means the person holding a system under a possession agreement;
- (c) “approved configuration” means the hardware and software configuration recorded in the conformity assessment for the system;
- (d) “attestation” means a cryptographic representation of a system’s current configuration capable of comparison against the published value for its approved configuration.

Article 3—Designated classes. The Commission shall by delegated act designate the classes of system to which this Regulation applies, having regard to the capability of the class to substitute for human labour and to the severity of harm a modified system of that class could cause.

Article 4—Title. Title to a regulated robotic system vests in the designated authority of the Member State in which it is first possessed. Title may not be transferred to a possessor.

Article 5—Possession. A regulated robotic system may be possessed only under a possession agreement granted by the designated authority. The agreement shall confer on the possessor, for its term—

- (a) exclusive possession;
- (b) the right to use the system for any lawful purpose;
- (c) quiet enjoyment, subject only to Articles 6B, 7 and 7A;
- (d) the right to assign, subject to the assignee's eligibility; and
- (e) the right to compensation for any deprivation of possession otherwise than for breach.

Article 5A—Entitlement. A possession agreement shall be granted on standard terms, without application under Article 6 and without refusal, to any eligible person seeking to possess a number of systems not exceeding the entitlement threshold. The entitlement threshold shall be prescribed by each Member State by reference to the household or single-person household, and shall be published. Articles 7, 7A and 8 apply to a system possessed under this Article.

Article 6—Application above the entitlement. A person seeking to possess a number of systems exceeding the entitlement threshold but not exceeding the industrial threshold shall apply to the designated authority, stating the intended use, the place of intended use and the number sought. The authority shall grant the application unless it is satisfied on stated grounds that it should not, and shall give reasons for a refusal.

The industrial threshold shall be prescribed by each Member State, and possession by an undertaking for use in its trade shall be treated as exceeding it irrespective of number.

The authority shall publish, at intervals of not more than one year and in aggregated form, the number of applications received under this Article by sector and by region. It shall not publish anything identifying an applicant.

Article 6A—Quantity and differentiation above the industrial threshold. Each Member State shall determine annually the number of possession agreements it will grant above the industrial threshold in each designated class, and may determine different numbers by—

- (a) sector of intended use;
- (b) region; and
- (c) category of applicant, including by size of undertaking and by whether the application is a first application or an expansion.

It shall publish each number together with the allocation rule and the reasons for both. Where a number is differentiated by region it shall be determined by reference to published labour-market data for that region and to the occupational classes it identifies as exposed.

Article 6B—Conditions of use, and the operative unit. A possession agreement granted under Article 6 or Article 6A may specify the sector and the region in which the system may be used, and use outside either is a breach. Compliance with a condition under this Article may be verified on an inspection under Article 7.

For the purposes of Articles 5A, 6 and 6A, systems in use at one site in one trade shall be counted together irrespective of the person in whom the several possession agreements are vested.

Article 7—Maintenance and inspection. The designated authority shall keep each regulated robotic system in repair and proper working order for the term of the possession agreement, at no charge to the possessor.

The authority may require a possessor to present a system for inspection at intervals prescribed for its class, and may inspect a system at the time of any maintenance carried out under the first paragraph. Where inspection requires entry to premises occupied by the possessor, it may be carried out only at reasonable times of the day and on giving notice in writing.

An inspection under this Article is limited to—

- (a) the physical integrity of the system;

- (b) comparison of its attestation against the published value for its approved configuration;
- (c) the operation of its safety-related constraints; and
- (d) where the possession agreement specifies conditions under Article 6B, the premises at which the system is kept and the trade in which it is in use, established by observation at the time of the inspection and not by reference to data held by the system.

An inspection shall not extend to data recorded, observed or generated by the system, and evidence obtained in excess of this Article is inadmissible in any proceedings.

Article 7A—Recall in emergency. Where a Member State has declared, under a statutory power subject to parliamentary reporting and judicial review, an emergency arising from armed attack, natural disaster, epidemic or mass displacement, the designated authority may recall regulated robotic systems.

A system recalled under this Article may be used only for—

- (a) the carriage, handling or distribution of humanitarian relief, food, water, fuel or medical supplies;
- (b) the movement, recovery or care of casualties;
- (c) the clearance of debris, the making safe of structures, or work in flooded, contaminated or confined spaces;
- (d) monitoring for civil-protection purposes; and
- (e) such further civil-protection tasks as may be prescribed, being tasks which do not make an effective contribution to military action.

A system recalled under this Article shall not be used for the transport of munitions, for engineering or construction in support of military operations, or for the carriage, mounting or operation of a weapon.

A recall under this Article—

- (a) shall not extend to a system in use for the personal care, mobility or medical support of an identified person, and that exemption shall not be capable of suspension;
- (b) shall be for a stated period, extendable only by a further decision subject to the same conditions;
- (c) shall carry payment to the possessor for the period of dispossession, at a rate prescribed in advance;
- (d) shall require the system to be delivered to, and operated from, premises designated by the authority, and it shall not be operated for any purpose under this Article while it remains at premises occupied by the possessor; and
- (e) is subject to appeal under Article 10.

A recall under this Article is the exercise of a right reserved in the possession agreement and is not an expropriation of the possessor's interest.

Article 7B—Supply, subsidy and servicing. A Member State may provide that regulated robotic systems are made available to possessors through the designated authority, on published terms available to all manufacturers on a non-discriminatory basis. Where it does so it shall—

- (a) publish the terms on which systems are offered, including any subsidy; and
- (b) require the possessor to report any modification of the system, both to the designated authority and to any insurer of it, as a condition of the agreement.

Article 7C—Systems reserved for defence purposes. A Member State requiring robotic systems for tasks excluded by Article 7A shall designate a separate class of system for that purpose. A system in that class—

- (a) may not be possessed by a natural person otherwise than in the course of a trade;
- (b) may not be kept at a dwelling;

- (c) shall be recorded in a register maintained separately from the register of possession agreements under Articles 5A and 6; and
- (d) shall be marked in a manner prescribed by the Commission.

Nothing in this Regulation permits a Member State to obtain a capability falling within this Article by means of Article 7A.

Article 8—Directives. Where a hazard is identified in a class of system already in possession, the designated authority may issue a directive requiring possessors to present systems of that class for correction within a stated period. Compliance is a condition of the possession agreement.

Article 9—Designated authority. Each Member State shall designate an authority for the purposes of this Regulation. The authority shall be functionally independent of the executive and of law-enforcement and security functions, and shall not disclose anything learned in the course of an inspection to any other body save as required by this Regulation.

Article 10—Forfeiture and appeal. A possession agreement may be terminated for breach. A possessor may appeal a refusal, a directive, a recall under Article 7A or a termination to a court or tribunal, which may quash, vary or confirm it.

38. Notes on the drafting

Article 3 makes the scope a delegated matter and states the two criteria. The alternative—defining the covered class in the Regulation—would either be over-inclusive on the day it entered force or obsolete within five years. Naming the criteria constrains the delegation, and the criteria track the two problems: substitution capability for displacement, severity of harm for modification.

Article 4 is the whole instrument in one sentence, and its brevity is deliberate. Everything else follows from title being retained.

Article 5 is longer than Article 4 because the possessor’s rights need to be exhaustive rather than residual. A possession agreement whose content is whatever the authority did not reserve is not a property interest, and the objection at Part VII §26 would then be unanswerable. Subparagraph (c) names all three qualifications on quiet enjoyment rather than only the inspection: a possessor whose unit is recalled under Article 7A has plainly had quiet enjoyment interfered with, and an instrument which said quiet enjoyment was subject *only* to inspection would contradict itself three Articles later. Subparagraph (e) is included because a possessory interest without compensation on deprivation is not one.

Articles 5A, 6 and 6A are the three bands and the drafting order matters. The entitlement comes first because it is what most possessors will ever encounter, and drafting it as a grant “without application and without refusal” states that the ordinary case involves no discretion at all. Article 6 is the disclosure band, and two features carry the argument at Part V §19.1B: the applicant states use, place and number, and the authority “shall grant unless satisfied on stated grounds that it should not”—a presumption of grant, which is what keeps the band a source of information rather than a queue. The publication duty in aggregated form is what converts the applications into the calibration data for Article 6A, and the bar on identifying an applicant is what stops the register becoming something else.

Article 6A is the only binding quantity and it is deliberately confined to the industrial band. It requires publication of the number, the rule and the reasons, and permits differentiation by sector, region and applicant. Regional differentiation does the most work, because displacement is a set of local events rather than a national aggregate, and it is tied both to published labour-market data and to the occupational classes identified as exposed, so that the number is defensible rather than merely announced. That is the response to Part VII §27: the paper cannot supply a costless allocation, and what it can require is that the allocation be stated and defended.

Article 6B is what makes the graduation enforceable and is two provisions in one. Without a condition on place and sector of use, a regional quantity is defeated by a possessor taking an agreement

where permission is easy and operating where it is not. Without the counting rule in the second paragraph, both thresholds are defeated by structuring—units held through separate persons, each below the line. The counting rule follows the goods-vehicle regime’s operating-centre logic, attaching to units in use at a site rather than to units on a balance sheet, and it works only because the inspection right under Article 7(d) can establish where a unit is and what it is doing. That Article is the clearest instance of the three capabilities depending on one another: the quantity control is only as good as the inspection right that verifies compliance with its conditions.

Article 7 opens with a maintenance obligation and that ordering is deliberate. The inspection right in the second paragraph is drafted as the correlative of the duty in the first, on the model of the implied covenants at Landlord and Tenant Act 1985 s 11, where the lessee’s covenant to permit entry for the purpose of viewing condition arises only where the lessor’s repairing covenant does. Part V §20.1 argues that this is what supplies the *reason* for the entitlement rather than merely its permission, and the drafting would lose that if maintenance were left to the permissive supply provision at Article 7B. The bounds on time and notice are taken from the same source.

The rest of Article 7 is a jurisdictional limit and not a policy. The inspection “shall not extend to” the data, and evidence in excess “is inadmissible”—a limit on power rather than an instruction to officials. Part VII §30’s answer to the surveillance objection depends entirely on this Article being read that way.

Article 8 is the airworthiness directive transplanted, and the capability no existing instrument in the field possesses. It is the practical payoff of Article 4: because title is retained, a corrective requirement reaching units in private hands needs no separate justification.

Article 7A does the most work and attracts the most suspicion, and the drafting reflects that. The trigger is statutory rather than executive, and is reportable and reviewable. The care exemption is expressed as incapable of suspension, because an exemption suspendable by the same power that authorises the recall is not an exemption. The recall is time-limited and carries payment for loss of use, which is what keeps the characterisation at Part V §20A.2 accurate rather than merely convenient. And the final sentence states that characterisation expressly, because leaving it to inference would invite the litigation the provision exists to avoid.

The exhaustive list of permitted uses, and the prohibition that follows it, are the most important lines in the instrument and they are there for the reason at Part V §20D. An earlier draft of this Article permitted recall “for use in defence, logistics, medical or humanitarian tasks” and stopped. That formulation is a standing statement of intended future use over every unit in the class, and “purpose” in the definition of a military objective means intended future use. Left as it was, the provision would have supplied a colourable argument that several million domestic machines — and the dwellings containing them — had acquired a military purpose by operation of the statute, before any emergency and without anyone doing anything. **The permitted tasks are therefore listed exhaustively and confined to civil-protection functions, and the excluded uses are stated expressly rather than left to implication.** The list tracks the civil defence tasks enumerated in Article 61(a) of Protocol I, and Part V §20D.3 sets out what that buys and on what condition.

Point (d) of the conditions on recall is the second half of that answer. A unit operated in situ converts the dwelling with it. Requiring delivery to designated premises before any use under the Article means the conversion, if it occurs at all, occurs openly and away from the civilian population, which is what Articles 51(7) and 58 of Protocol I require a party to try to achieve.

Article 7C exists so that the honest route to military capability is not closed but is separated. A state may perfectly well want robotic systems for tasks Article 7A excludes. What it may not do is obtain them by the household route because the household route is cheaper, and the closing sentence says so. The conditions track the Civil Reserve Air Fleet’s structural feature: the aircraft are committed, identified and kept at airports, so that whatever targeting argument they attract is an argument about airfields and not about houses.

Article 7B is the consent provision and it is permissive rather than mandatory. A Member State may operate the supply channel or not, and it is drafted permissively for the trade reason at Part VIII §32:

an exclusive channel engages the state-trading discipline, and a State unwilling to defend that may adopt the rest of the scheme without it, at the cost of a weaker answer to evasion. Subparagraph (b) borrows the motor-insurance model deliberately: a duty to report modification to an insurer is enforced by a party with a continuing commercial interest in its accuracy, which is a second enforcement channel operating at no public cost.

And Article 9's independence requirement is not decorative. The surveillance objection is answered, so far as it is answered, by attestation plus scope limit plus institutional separation, and removing any of the three collapses the answer.

39. What is deliberately absent

No robot tax. Part III concluded that revenue is a legitimate objective and a price signal a legitimate secondary instrument. Neither belongs here: mixing a fiscal instrument into a property instrument would confuse the objectives and give the whole scheme the appearance of a revenue measure, which is the surest way to have it litigated as one.

No general registration of use. The authority knows who holds an agreement and for what class, and above the entitlement it knows the use and place stated on the application. It does not know where the system is at any moment, what it is doing, or what it has recorded. That omission is deliberate and is part of the answer at Part VII §30.

No application requirement in the entitlement band. Article 5A could have been drafted as a light-touch application. It is not, because a permission that is always given is still a permission, and a scheme in which every household must ask is a different scheme from one in which almost nobody does.

And no discrimination between possessors on any basis other than the published allocation rule. Article 6A requires the rule to be stated; it does not permit the authority to depart from it.

Part X—Conclusions

40. Conclusions on each element

Two problems share a requirement and the field has not noticed. Displacement needs an instrument acting on a rate, continuously adjustable as conditions change. Modification needs a right to examine a unit in private possession during its operating life. Both require something that persists past the transaction, and every instrument in the field—fiscal or market-entry—attaches at a moment and is discharged there.

A price instrument cannot deliver a quantity and confers no access. It leaves the decision with whoever bears the cost, so the quantity that results depends on an elasticity nobody knows; it constrains the marginal adopter rather than the decisive one; and it is adjustable only by legislation, which is slow where the problem demands flexibility. Taxing a thing also gives the state no entitlement to examine it, which is why no fiscal proposal has ever been offered as an answer to modification. A fiscal instrument alongside a quantity instrument is coherent. Instead of one, it is a category error.

Market-entry regulation cannot reach the operating life, and the defect is structural. The Machinery Regulation's tampering provisions are design obligations discharged at construction; the Artificial Intelligence Act's architecture is supervisory over economic operators; the revised Product Liability Directive allocates loss after harm. The modification risk arises between placing on the market and injury, and nothing occupies that interval. Extending the market-entry framework would require a power of examination over private property that market-entry regulation has never needed and cannot justify from its own premises.

The retained interest supplies both from one structure. Title vests in the state; possession passes under an agreement conferring exclusive possession, use, quiet enjoyment, assignability and compensation. Quantity becomes a published administrative decision rather than an inferred consequence of a price. And the right to inspect follows from the reversion rather than being imposed alongside it, which supplies a coherent account of why the state may look and a principled bound on how far.

The quantity is graduated, and the graduation is where the instrument decisively beats a tax. Possession is as of right up to a household entitlement, follows a presumptively granted application above it, and is capped only at industrial scale. That places the restriction at the employment boundary, which is where displacement actually occurs and where the gain from substitution is captured; a tax cannot make that distinction, and charges the household that displaces nobody. **The middle band is the part with no fiscal analogue:** an application states use, place and number before deployment, so the tier that restricts almost nothing produces the data from which the tier that binds is calibrated. Within the capped band the number may be differentiated by sector, region and applicant, and the regional case is the one that matters, because displacement is a set of local events while fiscal instruments are national. A tax can carry differential rates and cannot verify that a taxpayer's stated category is the true one; a licence conditioned on place and sector of use is checked on the inspection the modification problem already requires. The capabilities are mutually dependent rather than merely compatible, and the shape is not speculative—goods-vehicle operator licensing has run it over privately possessed chattels since 1970.

And a third capability follows which was not in the original conception. Because title never passes, emergency recall is the exercise of a reserved right rather than a taking, so a state obtains a contingency reserve funded by private consumption and callable without expropriation. Where the state also operates the supply channel it obtains that reserve at a fraction of procurement cost, because it buys as a monopsony, retains the residual, and the machines are housed by the people using them, so that the one holding cost the state bears is the servicing that is also its inspection. The precedents are old: privately owned airliners have been committed to military airlift since 1951 and forty-five merchant ships were taken up from trade for the Falklands. The drafting answers the obvious objections with a statutory rather than executive trigger, a care exemption incapable of suspension, time limits, and payment for loss of use.

Stating that limb plainly is what exposed the paper's most serious problem, and it is a targeting problem rather than a property one. "Purpose" is read, in the definition of a military objective, as intended future use. A statute which reserves every unit of a designated class for defence tasks therefore makes a standing declaration about the future use of all of them, and would confer a military purpose upon millions of domestic machines — and raise a question about the dwellings holding them — before any emergency and without any act by anyone. The contractual civil-reserve arrangements on which the paper draws escape this by accident of location: aircraft sit at airports and ships in ports. **A reserve distributed across the residential building stock has no such escape.** The response is a drafting discipline — permitted tasks listed exhaustively and confined to civil protection, munitions carriage and weapon operation excluded expressly, delivery away from dwellings before use, and a separate designated class for anything beyond that — and §20D.4 concedes that it mitigates rather than answers. A state unwilling to accept the residual argument should take the scheme without the recall limb.

Airworthiness is the working precedent and it is closer than the obvious comparators. It combines private ownership, a continuing conditional certificate, scheduled rather than suspicion-based inspection, compulsory post-sale modification control by directive, and an arm's-length technical inspectorate—the exact combination this proposal needs. Its scheduled-inspection feature answers a circularity the modification problem otherwise creates, and its directive mechanism is the capability no robotics instrument currently possesses. Where the analogy fails is on scale, and that is conceded rather than argued away.

The objections are answered in part and one is not answered at all. Prospectivity meets the property objection. Forced publication of the allocation rule improves on silent distribution by ability to pay without solving it. Attestation-based inspection is designed for scale but has not been demonstrated at it. And the surveillance objection is met by attestation yielding one bit, by a jurisdictional rather than instructional scope limit, and by institutional separation—none of which guarantees those limits hold under pressure.

And the comparative conclusion is uncomfortable and is stated plainly. A retained-interest scheme is easiest for states with weak property protections and hardest for those with strong ones. The design choices at Part V §20 exist to narrow that asymmetry and do not eliminate it. The argument for pressing on is that the alternative is not the absence of the instrument but the absence of the capability: liberal states addressing displacement fiscally and modification not at all, while others do both.

41. What would change the analysis

A demonstration that a tax can be calibrated to a quantity, which would require a reliable elasticity estimate. Part III says none exists and the claim is falsifiable by producing one.

Evidence that attestation-based inspection does not scale, which is the proposal's most vulnerable point and is identified as such at Part VI §25 and Part VII §28.

A finding that a retained interest does not carry an inspection right of the required scope without express statutory provision, in which case the property route is doing no work a statutory power could not do directly and its doctrinal advantage is illusory.

And a workable design that is not easier for authoritarian states than for liberal ones. Part VIII §36 attempts one and does not claim success. Somebody producing a better answer to that asymmetry would improve this proposal more than any other single contribution.

42. Summative remarks

The instruments being built for robotic systems are all instruments of the transaction. They tax the purchase, regulate the placing on the market, and allocate the loss after the injury. Each is well made and each is complete before the thing it governs has done anything.

What both of the problems approaching actually require is a relationship rather than an event: something that persists while the machine does, so that the number in circulation can be adjusted as conditions change and the state of any particular unit can be established while it is still in use. Property is the ordinary legal form of a persisting relationship with a thing, and a retained reversion is the least invasive version of it that supplies what is needed.

The proposal is uncomfortable and should be. It asks that a class of machine be held rather than owned, and it creates a routine entitlement for a public body to interrogate a device in a private home. The paper's answer is that the entitlement can be confined to a single bit of information by design rather than by promise, that the confinement can be jurisdictional rather than instructional, and that aviation has run an analogous arrangement for decades without it becoming something else.

That answer is partial, and the place it is weakest is the place the paper has said so. What it offers against the discomfort is that the two problems are real, that the instruments currently proposed cannot address them, and that the reason is the same in both cases and is now identified.

Appendix—The Inspection Protocol, and What It Can and Cannot Reveal

Part VII §30 concedes that the surveillance objection is the one most likely to defeat this proposal, and answers it by asserting that an attestation-based inspection yields one bit of information and nothing else. That assertion is load-bearing and should not be taken on trust. This Appendix sets out what the protocol does, what it discloses, and what it does not, so that a reader can test the claim.

The protocol described is standard in outline and is not novel to this paper. What is offered is its application, and the analysis of what follows for the objection.

A.1 What is established at approval

At conformity assessment the approved configuration is fixed and documented.⁶⁵ A cryptographic digest of that configuration—the firmware, the safety-related parameters, and the constraints imposed at manufacture—is computed and published in a register.

⁶⁵Machinery Regulation (n 2), and Part IV §17 on the conformity assessment as the reference against which an attestation is compared.

Two features matter.

The published value discloses nothing about the configuration. A digest is a one-way function of its input: publishing it does not permit the configuration to be reconstructed, which matters because manufacturers will not accept publication of their software and should not be asked to.

And the value is fixed and public. Anyone may look up what an approved unit of a given type should attest to.

A.2 What happens at inspection

The inspector supplies a random challenge. The unit computes an attestation over its current configuration together with the challenge, using a key held in hardware, and returns the result. The inspector verifies the signature and compares the digest against the published value.

Three properties follow, and they are what the objection turns on.

The challenge prevents replay. A modified unit cannot present a previously recorded valid response, because the response is a function of a value the inspector chose at that moment.

The comparison yields a single bit. Match, or no match. A match establishes that the configuration is the approved one. A mismatch establishes that it is not, and says nothing about what it is instead.

And nothing else is transmitted. The protocol carries a challenge and a signed digest. It does not carry the code, the logs, the sensor history, or any data the unit holds. There is no step at which the inspector has access to anything from which anything about the household could be inferred, because no such thing is sent.

A.3 What the inspection cannot reveal, stated as a list

Because this is the substance of the answer at Part VII §30, it is worth being explicit. The protocol does not reveal:

- what the unit has seen, heard or recorded;
- where the unit has been within the premises, or when;
- who is present in the household, or how many;
- what tasks the unit has performed;
- when the unit has been in use;
- anything about any other device on the premises; or
- what the modified configuration is, where a mismatch is found.

The last is worth pausing on because it is counter-intuitive and it is a genuine limit of the method rather than a feature. **A mismatch tells the authority that the unit is not in its approved state and does not tell it what state it is in.** Establishing that would require an examination of a different and far more intrusive kind, and the drafted Article 7 does not authorise one. What follows a mismatch is therefore that the possession agreement's condition is breached and the unit must be restored or surrendered—an administrative consequence, not an investigation.

A.4 What the protocol assumes, and where it fails

Three assumptions, and each is a place the answer at Part VII §30 could fail.

A hardware root of trust that resists extraction. The attestation key must be held so that a possessor cannot extract it and sign a false attestation for a modified unit. This is a well-developed area and it is not a solved one; a sufficiently determined and resourced attacker defeats most such arrangements. *Assessment: this bounds the regime's effectiveness against determined evasion and does not bound its effectiveness against the ordinary case, which is the owner who removes a speed limit.*

That the approved configuration is a meaningful constraint. If a configuration is broad enough to encompass dangerous behaviour, attesting to it establishes nothing. The regime is therefore only as good as the conformity assessment beneath it, which is a reason to build on the machinery framework rather than beside it.

And that the protocol is not extended. Everything in A.3 depends on the inspection carrying only a challenge and a digest. An amendment permitting the inspector to request a log extract, for any reason however good, converts the regime into the thing the objection describes. *Assessment: this is why Article 7 is drafted as a jurisdictional limit with an inadmissibility consequence, and why Part VII §30 concedes that the design makes surveillance harder rather than impossible.*

A.5 What this Appendix establishes

That the one-bit claim is technically accurate for the protocol as described, and not a rhetorical simplification.

That the residual risk is a governance risk rather than a technical one. The protocol does not accumulate a surveillance capability; a future amendment to the protocol could create one. Those are different objections and the second is not answered by engineering.

And that a reader who regards the governance risk as decisive has a coherent position. Part VII §30 says so and this Appendix does not improve on it. What the Appendix establishes is where exactly the disagreement lies, which is the most a paper in this position can honestly do.
