

The Architecture of Dependence: Control Points, Value Capture and Capability in the Digital Stack

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Draft working paper v0.3, 2026-10-08. Measurement and theory. The rents are measured on the capital the UK competition authority counts, from company filings and competition authorities' findings, with their range under other definitions of capital and over five fiscal years in Appendix C; the edges of spreading control are checked against a census of the annual filings. The propositions have proofs in Appendix A and numeric cross-checks in the reproduction scripts. Proposition 7 is proved for linear demand and for two holders under any demand; for three holders under other demand shapes, it rests on a Monte-Carlo check.

ABSTRACT

European organisations buy their digital technology through a stack of complementary layers, from chips to cloud, software, AI models and payment rails. This paper maps the stack's control points, positions many others depend on, costly to substitute and held by few: 39 positions from rated public sources, 27 of them control points, and 66 edges checked against 88 annual filings. It measures the rent each control point earns, the share of income above the cost of capital on the UK competition authority's definition of capital: 48 cents of each euro at the leading accelerator maker, 25 at Microsoft's productivity suite, 22 at the leading foundry, 6 to 11 in cloud infrastructure and 32 to 39 at the card schemes. The median control point earns 11 cents against 2 where several suppliers compete, under every coding of the map. The holders of lower control points earn their margin on what the positions above them buy, so backing runs up the stack against the payments: 12 of 17 documented financings run along a payment path back to the backer, where 2.5 percent of pairs of positions have one. Opening a control point lowers buyers' prices and raises the remaining holders' rents. Europe's four control points earn 0 to 15 cents per euro, largely from outside Europe, spend more on research than they earn in rent, and anchor no industry above them. Cloud is the worked example: its rent on European revenue was at least EUR 3.1 billion in 2024.

Keywords: control points, value capture, economic rent, complementary monopoly, vertical chains, platform envelopment, cloud computing, digital sovereignty.

JEL: L13, L14, L22, L42, L86, F12, F23.

1. INTRODUCTION

Most of the digital technology European organisations use is designed and sold by firms headquartered elsewhere. In cloud infrastructure, the three US leaders hold 70 percent of a European market of EUR 61 billion, while European providers' share fell from 29 percent in 2017 to 15 percent, where it has stayed since 2022 (Synergy Research Group 2025). European providers lost that share while being cheaper on commodity infrastructure (Fermigier 2026c). Whether this dependence costs Europe anything has to be answered layer by layer, across the whole stack.

The case that it costs little is strong. A country gains from a technology mainly by using it, and can prosper by importing the technologies in which others hold an advantage, because the users' productivity gains stay at home. The European productivity gap with the United States has been traced to the sectors that use information technology and to how firms use it, more than to where the technology is made (van Ark, O'Mahony and Timmer 2008; Bloom, Sadun and Van Reenen 2012). Where a layer of the stack is competitive, this argument is

largely right: buyers keep most of the gains while the supplier earns little above the cost of its capital.

The argument stops where a supplier holds a control point. A control point lets its holder recapture part of the user's gains through renewal prices, metering, tied licences or a take rate, so the gains from use leave with the margin. The captured margin also finances the holder's next position, so the loss compounds. Producing is worth more than using in three further cases: rents in industries with increasing returns (Krugman 1987; Brander and Spencer 1985), the capabilities production builds (Juhász 2018; Juhász, Lane and Rodrik 2024), and control over the product's evolution.

The paper proceeds in four steps, with cloud infrastructure as the worked example at each one.

- **A map.** Section 3 maps the stack's control points from rated public sources: competition authorities' findings, audited filings, analysts' figures and the paper's own measurements.
- **The rent.** Section 4 measures the rent each control point earns, as a floor: income above the cost of capital, on the method the UK Competition and Markets Authority (CMA) applied to cloud.
- **Two mechanisms.** Section 5 shows why control spreads up the stack, and section 6 what opening a control point does to who earns what. Each comes with propositions proved in Appendix A.
- **Alternatives.** Section 7 sets the measured architecture against three alternatives (a European holder, a contested control point, an open interface) and measures each in two ways: by the value captured abroad, and by the European buyers' welfare.

The paper reaches four results.

1. **Value sits at a few control points.** On the CMA's definition of capital, the rent is 48 cents of each euro buyers pay at Nvidia, 25 at Microsoft's productivity suite, 22 at TSMC and 6 to 11 in cloud infrastructure; the card schemes earn 32 to 39. Under the most adverse treatment of research as capital, the first three are 40, 13 and 16, and the schemes, which file no research line, are unchanged. Counted by position, the median control point earns 11 cents and the median position where several suppliers compete 2 cents; network operators and server makers earn nothing, and the two distributions overlap. A one-sided permutation test puts the chance of a gap this large under no difference at 5 percent. Under every alternative coding of the map, the gap stays between 9 and 13 cents. Averaged over five fiscal years, the card schemes come first, then Nvidia. In cloud, the rent on the leaders' European revenue was at least EUR 3.1 billion in 2024, out of about EUR 15 billion of operating income. At most EUR 7.2 billion of it is a normal return; EUR 4.7 billion, Google's part and Microsoft's income above a 20 percent margin, is left unclassified.
2. **Backing runs up while money runs down.** A position's suppliers earn their margin on what it buys, so the holders of lower control points outbid financial investors for backing the positions above them, as long as they have the capacity to serve the extra demand. The map's 38 documented edges of spreading control, checked against a census of the 88 annual filings of the archive, fall in three classes. Six of the seven equity stakes run up the stack, each along a payment path, as the mechanism predicts: five finance model developers, and the sixth is Nvidia's in Nokia, whose radio networks now use Nvidia's processors. The seventh, Nvidia's in Intel, stays within chip design. Twelve of the 17 documented financings between the map's holders run along a payment path back to the backer, where 2.5 percent of the ordered pairs of positions have one. The 23 positions that holders built or bought run both ways. What they build for their own supply runs down; their acquisitions run mostly up, half of them into the two competitive positions of security and integration. The eight extensions of an installed base by bundling, licensing or store terms run up by the order of the layers, which a payment

fixes for three of them. In six loops the backed firm pays its backer back: Microsoft holds about 25 percent of OpenAI, and recorded USD 24.1 billion of revenue from it in fiscal 2026, revenue-sharing payments included.

3. **Opening moves value to the next control points.** Opening a control point lowers buyers' prices, and raises the rents of the holders that remain. Along a vertical chain with linear demand, every remaining holder's profit at least doubles. Where those holders are abroad, opening helps European buyers without lowering the value captured abroad, unless demand is so concave that the remaining holders' profits barely rise.
4. **Europe's holds earn value without anchoring capability.** Europe holds four of the 27 control points: lithography, mobile-network equipment, mobile-network patents and enterprise resource planning (ERP). Where measurable, they earn 0 to 15 cents per euro, less when research is counted as capital, paid largely from outside Europe, and spend 14 to 24 cents of each euro on research. Two of the 38 edges of spreading control leave them, one a stake and one a build.

The paper joins three lines of work. Studies of industry architecture locate value capture at bottlenecks. The literature on complementary monopoly says what happens to prices when a component opens. Competition authorities measure the returns of a few holders. No study, to our knowledge, maps the control points of the whole stack, measures the rent each one earns against the cost of capital, and connects them by the mechanisms through which control spreads.

Section 2 reviews the literature. Sections 3 to 7 follow the four steps. Section 8 reads the results for Europe's own holds, section 9 for policy, and section 10 sets out the limits.

2. RELATED LITERATURE

Industry architecture and appropriation. Teece (1986) placed the returns to an innovation with the holders of the complementary assets it needs, and extended the argument to the standards and licensing of the digital economy (Teece 2018). Jacobides, Knudsen and Augier (2006) located value capture at the bottlenecks of an industry's architecture, and Baldwin (2018) at the bottlenecks of a modular system, building on Baldwin and Clark (2000). The control points of this paper are those bottlenecks, identified from evidence, layer by layer; where the hold is an installed base, they are the switching costs of Farrell and Klemperer (2007).

Complementary monopoly and vertical chains. When several firms each sell a component that buyers need together, each prices without counting the sales its price costs the others (Cournot 1838), so the total price exceeds what a single seller would charge. Economides and Salop (1992) studied how integration among complements changes prices; Buchanan and Yoon (2000) showed that adding holders of complementary rights lowers the total value captured, the tragedy of the anticommons. Along a vertical chain, each seller's markup adds to the markups before it (Spengler 1950). The same arithmetic governs royalty stacking, where each holder of a patent that a standard needs adds its royalty to the others' (Shapiro 2001; Lemley and Shapiro 2007). Section 6 restates these results for the stack and adds what they imply for who gains, by jurisdiction, when one component opens: the delta is the jurisdiction of the holders.

Platforms, ecosystems and envelopment. Bresnahan and Greenstein (1999) traced how competition in computing shifted between layers. West (2003) and Pon, Seppälä and Kenney (2014) showed how opening one layer moved control to the next: from the operating system to the services and the store. Eisenmann, Parker and Van Alstyne (2011) described envelopment, a platform entering an adjacent market through the user base it shares. Gawer and Cusumano (2014) and Jacobides, Cennamo and Gawer (2018) gave the theory of the ecosystems in which these positions sit. Section 5 adds a mechanism for which positions a holder enters: those whose purchases pay it back.

Vertical integration and its direction. Which stages of a sequential chain a firm integrates, and in which direction, is the question of [Antràs and Chor \(2013\)](#). Their answer turns on the elasticity of demand and on whether the stages are complements or substitutes; [Alfaro, Antràs, Chor and Conconi \(2019\)](#) test it on firm-level data. The older answer is hold-up: a firm integrates the supplier whose specific assets would otherwise let it be held to ransom ([Klein, Crawford and Alchian 1978](#)). Section 5 adds a third motive, payback, and section 5.4 separates the edges it explains, the equity stakes, from the positions holders build or buy, where hold-up, supply assurance and envelopment are the better readings. Equity stakes between suppliers and customers have their own evidence: [Allen and Phillips \(2000\)](#) and [Fee, Hadlock and Thomas \(2006\)](#) find them where the parties' relationship is specific and the backed firm needs the capital, which is Proposition 1's setting.

Intellectual monopoly in value chains. [Durand and Milberg \(2020\)](#) and [Rikap \(2021\)](#) argued that lead firms in global value chains capture rents through intangible assets they control. This paper measures such rents at the stack's control points, against the cost of capital, from public filings.

Markups and pure profits. [De Loecker, Eeckhout and Unger \(2020\)](#) estimate markups from firms' accounts and find them rising in the United States since 1980, driven by the upper tail of the distribution. [Barkai \(2020\)](#) measures the cost of capital directly, as the required return times the capital stock, and finds that a rising share of pure profits offsets the falling shares of labour and capital. [Basu \(2019\)](#) shows how far such estimates depend on their assumptions. [Karabarbounis and Neiman \(2019\)](#) show that the same residual income can be read as capital the accounts miss or as a higher required return. [Crouzet and Eberly \(2023\)](#) separate the part of firms' valuations due to rents from the part due to intangible capital. [Peters and Taylor \(2017\)](#) and [Eisfeldt and Papanikolaou \(2013\)](#) capitalise part of selling and administrative expense as organisational capital. [Demsetz \(1973\)](#) reads a concentrated industry's profits as the return to the efficiency that won the share. The rent of this paper is Barkai's pure profit, measured holder by holder at the control points, on the capital the CMA counts; section 4.1 says what it cannot separate, and Appendix C tests it against the intangible-capital readings by capitalising research and organisational capital.

Competition authorities. The Autorité de la concurrence (2023) and the CMA (2025) investigated cloud markets in France and the United Kingdom; the CMA's profitability analysis (Appendix E) measured the leaders' returns against their cost of capital. Section 4 extends that method to the other layers, with the floors the public filings allow.

Payment cards. The card schemes sit on a two-sided platform whose fees [Rochet and Tirole \(2002, 2003\)](#) analysed, and whose interchange fee the EU capped in 2015 while leaving the schemes' own fees uncapped ([European Parliament and Council 2015](#)). Section 3.3 says why the schemes are on the map, and section 4 measures their rent on the same method as the other holders'.

The same programme. *Path Sovereignty* measures who can cut whom in the stack ([Fermigier 2026e](#)). *Channels of Power* lists the fifteen channels through which dependence acts ([Fermigier 2026b](#)). *Sovereignty as a Flow* documents the acquisition of European technology firms ([Fermigier 2026f](#)). *Exit, Pursued by a Bill* shows that, at the level of a single buyer, the incumbent's markup equals the buyer's cost of leaving ([Fermigier 2026d](#)). *Cheaper and Losing* explains why cheaper European cloud providers lost share ([Fermigier 2026c](#)). The cloud services matrix measures exit friction service by service ([Fermigier 2026a](#)). Where *Path Sovereignty* measures exposure, who can cut whom, this paper measures value and capability: where value is captured across all layers, how control spreads between them, and where capability builds.

3. THE STACK AS AN ARCHITECTURE

3.1 Control points

A control point is a position in the stack (a component, an interface, an asset or a relationship) that many other positions depend on, that is costly to substitute, and that one or a few actors hold. Technology creates control points: proprietary interfaces and formats, data held where it is costly to move, ecosystems of complements, scale in capital spending. Non-technological dependencies hold them in place: licensing terms, procurement habits, skills and certifications, credits, standards, jurisdiction. The distinction matters for remedies, since a technical opening leaves the non-technological holds in place. Each of the three criteria is coded from its own evidence. Dependence is documented in the project's layer sheets, position by position, and a position enters the map only once its dependants are listed. Concentration is coded from market shares, the number of suppliers and authorities' findings of dominance. Substitution cost is coded from a rated finding that buyers are tied or that no substitute exists, and marked "not measured" where no such finding exists; Appendix B gives it for every control point and section 3.3 counts them.

3.2 Sources and ratings

Every figure the paper uses states what it measures and has a rating:

- **A**, an official measure of the right object: a competition authority's finding, a court's, a central bank's;
- **B**, an audited filing: segment results from the 10-K and 20-F filings, read from their XBRL data;
- **C**, an independent analyst or press report;
- **O**, the paper's own measurement from public data;
- **D**, a sponsored study, which the paper does not rely on.

A figure is established when two independent sources agree. The paper's own measurements are four:

- **Mail**. The domain-name records of 1,307 EU listed companies, 1,803 universities and 349 ministries show who hosts their mail, who filters it, and whether a Microsoft 365 tenant is attached.
- **Traffic**. Cloudflare Radar's human-traffic shares of operating systems and browsers, by member state.
- **Interconnection**. PeeringDB's registry of 1,222 internet exchanges and their connected capacity.
- **Web edge**. The address records of the same companies', universities' and ministries' websites show which network serves them. US edge networks serve 39.0 percent of the listed companies' websites, 18.3 percent of the ministries' and 9.4 percent of the universities'.

The paper also reads the responses of 9,758 professional developers in the EU to the 2025 Stack Overflow survey (Stack [Overflow 2025](#)), a self-selected sample rated C, for the platforms they have worked with.

3.3 The map

The stack is grouped into thirteen layers, from fabrication and equipment to distribution and intermediation. One of them, the attention and advertising layer, covers search, social networks and advertising. Its payers are advertisers rather than organisations buying technology, so its figures are reported apart and never added to the others'.

The map codes 39 positions. 27 are control points, each on rated evidence. Ten positions are competitive, with several suppliers and no holder, and two are run by public bodies or non-profits: internet exchanges and public mail. Appendix B lists them. The x86 processor,

once the stack's control point, is competitive between Intel and AMD, with Intel at an operating loss in 2025. Three other positions often described as bottlenecks are competitive on the evidence. In data-centre switching, Arista held 19 percent of the market and Nvidia 15.2 percent in the fourth quarter of 2025 (IDC 2026a). In customer relationship management (CRM), the leader, Salesforce, held 21.7 percent in 2023 (Salesforce 2024). In firewalls, identity and security monitoring, the European Parliament's study finds US and Israeli vendors dominant as a group (Gineikyte-Kanciere, Eggert and Skiotyte 2025), which makes it a dependence on one jurisdiction with no single holder; the five listed vendors compete. Positions are classed by structure (market shares, the number of suppliers, an authority's finding of dominance), never by margin. Of the 27 control points, 15 also have a rated finding on substitution (Appendix B). Nine rest on an infringement decision, a court's finding, a regulator's market review or study, or a sole-supplier fact. Two rest on a designation of an entrenched position, section 19a for Windows and the Digital Markets Act for Meta's social networks, and four on a commitments decision or a policy restriction, which state a concern rather than a finding. The other 12 rest on concentration. A rule requiring both criteria would keep 15, or nine on the strictest reading of a finding. Section 4.3 reports the rents for both sets, and recoding the two oligopolies of three or four suppliers, process equipment and memory, as competitive leaves both medians unchanged.

The card schemes are on the map although their buyers, banks and merchants, buy a payment service. Every digital sale runs on their rails, two schemes handle 61 percent of euro-area card payments (European Central Bank 2025), and the UK regulator found their fees rising without competitive constraint (Payment Systems Regulator 2025). Their market is two-sided (Rochet and Tirole 2002, 2003), and the EU caps the interchange fee between banks, not the schemes' own fees (European Parliament and Council 2015); the rent measured in section 4 is on the latter. The models of section 6 do not describe the position, as Table 4 notes.

Between the positions run 66 sourced edges, counted in Table B1 (Appendix B):

- 38 edges of propagation, where the holder of one position takes a position in another. An edge is coded for every such position-taking that a filing, an authority's decision or a rated source documents. The edges fall in three classes: equity backing (7 edges); make or buy, where the holder builds, acquires or integrates the position (23); and bundling, licensing or terms that extend an installed base (8);
- 12 payment edges, where one position pays another;
- 16 edges of reach, where a jurisdiction acts on a position.

The propagation edges are checked against a census of the filings. Every sentence of the 88 annual filings in the archive, the latest and the preceding one of each of 44 filers, that names an acquisition, a merger, a stake, a warrant or a joint venture was read, and its counterparty coded (verify/edge_census.py). The filings name 269 counterparties. Of these, 125 sit in a mapped position. Of those mentions, 28 fall on 18 of the map's edges, 11 of which the census added; 56 lie within the filer's own position. The other 41 are another firm's transaction, a mention without a transaction, a disposal, an abandoned or pending deal, a warrant, or a filer that holds no mapped position. The other 144 sit in a layer the map does not split into positions, or outside the stack.

The layers are ordered by the payments: a layer sits below another when the second pays the first, directly or through other layers. That rule fixes the order along the AI chain, where the model developers pay the cloud, the cloud pays the accelerator maker, the accelerator maker pays the foundry and the foundry pays the equipment makers, and between the applications and the cloud. Where no coded payment runs between two layers, their relative height is a drawing convention, and section 5.4 reports which edge directions rest on it.

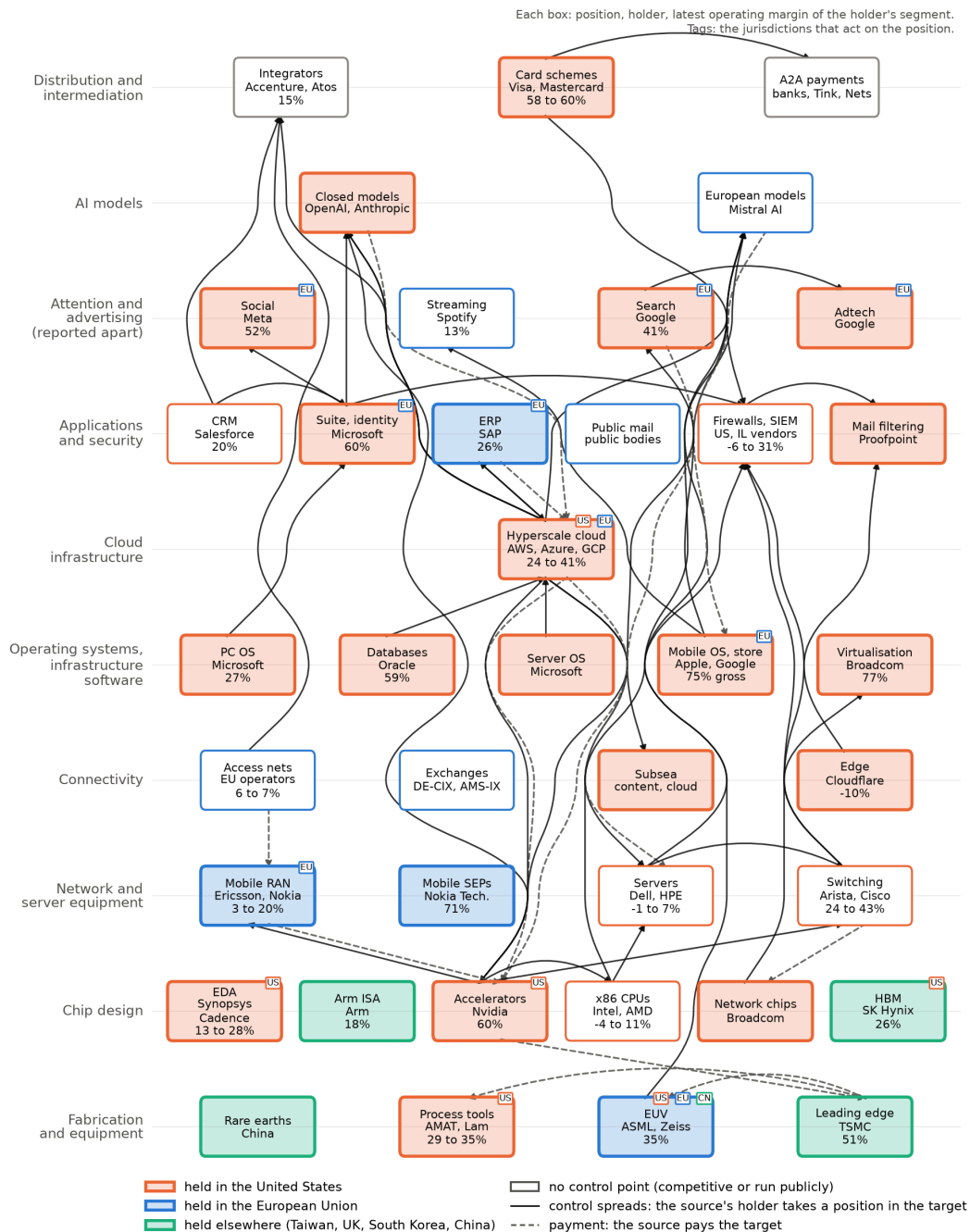


Figure 1. The architecture map. Rows are the levels of the stack, from fabrication at the bottom to distribution at the top. Tinted boxes are control points, bordered and tinted in the colour of the holder's home; white boxes are positions without one, bordered in their holders' colour, or grey where the holders come from several places. Each box shows the latest operating margin of the holder's segment, or its gross margin where only that is filed; segment margins come before the group costs Table 1 charges (section 4.1). Solid arrows: the source's holder takes a position in the target. Dashed arrows: the source pays the target. Tags: the jurisdictions that act on the position. Source: `verify/architecture_map.py`.

The holds the evidence documents best are contractual: licensing, price or maintenance terms hold 10 of the 27 control points, each found by an authority, a court or a filing. At lithography the hold is the technology itself. Skills and habits are named as holds at six control points. Skills are measured at one of them, the cloud (section 3.4), and habits at none,

which is the largest gap in the evidence. And Europe holds four control points, all at the bottom or in the middle of the stack: lithography and its optics, mobile-network equipment, mobile-network patents, and ERP.

3.4 Cloud infrastructure, the worked example

Concentration is established. The three US leaders (Amazon Web Services, Microsoft Azure and Google Cloud) hold 70 percent of European cloud infrastructure revenue (Synergy Research Group 2025). The national figures of three competition authorities agree: 71 percent in France in 2021, 85 percent in the Netherlands in 2020, and 65 to 90 percent in the United Kingdom in 2024. The figures come from the Autorité de la concurrence (2023), the Dutch authority as tabulated by OECD (2025), and the CMA (2025).

The control points are technical, and held in place by contracts.

- **Proprietary managed services.** Code written against a provider's managed databases, functions or AI services moves only by rewriting it. Exit friction measured service by service reaches 0.90 on a scale of 0 to 1 for AWS's DynamoDB (Fermigier 2026a).
- **Data gravity, priced by egress fees.** One major provider's outbound bandwidth revenue in France grew more than sixfold from 2018 to 2021, while its cloud revenue tripled (Autorité de la concurrence 2023, §§448 to 450).
- **Licensing that ties layers.** The CMA found that Microsoft's licensing makes its software dearer to run on rival clouds than on Azure (CMA 2025).
- **The breadth of the ecosystem.** Competitive bidding "will generally lead to the selection of a supplier who will cover the customer's entire need" (Autorité de la concurrence 2023).
- **Credits that set the default for new firms.** Start-up credits reach USD 200,000 at Google Cloud, 150,000 at Microsoft Azure and 100,000 at AWS, against EUR 36,000 at Scaleway and 20,000 at 3DS Outscale (Autorité de la concurrence 2023, §150).
- **The scale of capital spending.** AWS's capital expenditure reached 75 percent of its revenue in 2025.

Skills sit with the leaders. The 2025 Stack Overflow survey asked developers which platforms they had done extensive work on in the past year. Of the 7,297 professional developers in the EU who answered, 63 percent named AWS, Azure or Google Cloud: 36 percent AWS, 27 Azure and 21 Google Cloud. The 42 platforms they chose from the survey's list include no European cloud provider; 1 percent of them wrote one in (Stack Overflow 2025). The sample is self-selected, so the shares measure where skills sit among developers who answer such surveys.

Sovereign wrappers leave the control point in place. The offers that license a US provider's technology to a European operator (Bleu, S3NS, Delos) change who operates the service and which law reaches it. The technology, its roadmap and the licence income stay with the licensor.

4. WHERE THE RENT SITS

4.1 Measuring the rent

The rent is the income a holder earns above the cost of the capital it employs. With ROCE the pre-tax return on capital employed and r the pre-tax cost of capital, the rent is the share $1 - r/\text{ROCE}$ of operating income. The normal return on capital is no loss to Europe, since the same capital would have earned it elsewhere. Nor are the costs a supplier spends in Europe, or the equipment any holder would import. A holder's **rent rate** is the cents of rent in each euro its buyers pay: its operating margin times its rent share. The rate needs no European revenue, which most filings do not give, and it compares across layers.

The measure is an excess accounting return, and three readings of it compete. It can be a rent from the control point, the reading the paper tests. It can be a quasi-rent on an innovation that competition has not yet caught up with (Demsetz 1973). Or it can be the return on capital the accounts do not show: the research, software, brands and organisation the filings write off (Karabarbounis and Neiman 2019; Crouzet and Eberly 2023). Nothing in a single year's return separates the three. The paper therefore ties the excess to a control point by the structural coding of section 3.3, which comes before any rate is computed. Appendix C then measures how much of each rate remains when research and organisational capital are counted as capital and when three years are averaged. The headline rates are stated on the CMA's definition of capital, which keeps the comparison with its cloud findings, and travel with their range.

The return on capital is taken as a floor from the filings. For cloud, the CMA's own returns are used: AWS's has been "consistently in excess of 20%" (CMA 2025, Appendix E, §E.184), Azure's above 20 percent in the last three years, and Microsoft's Cloud and Enterprise business above 45 percent from 2018 to 2024 (Appendix E). For the other holders, the floor is the group's operating income over its total assets less goodwill. The CMA treats operating income over total assets as "a conservative lower bound" (§E.181). It excludes goodwill from capital employed, since this "avoids the risk of capitalising any economic profit" (§E.93). Goodwill matters most at the acquirers: it is 57 percent of Broadcom's assets, 56 percent of Synopsys's, 52 of Salesforce's, 46 of Cisco's and 41 of SAP's. Keeping it in the capital, as the CMA's total-assets measure does, lowers their rates most (Appendix C).

Three items stay in the base and understate the rent: cash and securities, which are large at Apple, Alphabet, Microsoft, Meta and Nvidia; acquired intangible assets other than goodwill; and current liabilities, which the CMA nets off. Research works the other way. The filings expense it, so the capital it builds is missing from the base. The CMA counts an intangible asset only if it meets its criteria, and assumes that the relevant ones sit in the reported total assets (§§E.85 to E.87). The floors are floors on that definition of capital; Appendix C capitalises research and organisational capital to test them. A segment's margin is paired with its group's return only where the segments add up to the group (Microsoft, Meta). Microsoft's Productivity and Business Processes segment includes LinkedIn and Dynamics, a fifth of its revenue, and its More Personal Computing segment includes Xbox, Surface and search advertising beside Windows. Microsoft files no margin by product, so the suite's and the PC system's rates are segment rates. Broadcom states its segments' profits before the costs it leaves unallocated; Apple states them before research. For both, the group margin is used. Google Services is charged in full with Alphabet's group-level costs, which "primarily reflect expenses related to our shared AI research and development" (USD 16.76 billion in 2025).

The cost of capital is 14 percent, the upper value of the CMA's benchmark for AWS's and Microsoft's cloud businesses (§E.164), with 10 percent as a sensitivity. Applying it to every holder is an assumption, and Appendix C replaces it with each sector's own.

Table 1 covers every holder named in Appendix B that files with the US Securities and Exchange Commission and whose filing gives an operating income and a balance sheet: 37 holders at 25 positions, with the two cloud rows on the CMA's returns. Each holder has one row, at the position its filing describes, with a segment where the filer reports one; Broadcom's group sits at virtualisation, the position the Commission and the Dutch court examined. The holders outside that filing system (Capgemini, Atos, Sopra Steria and Orange among the integrators; Samsung and SK Hynix in memory; Tokyo Electron and Zeiss in equipment) and the private ones (OpenAI, Anthropic, Mistral AI, the contract makers) have no rate. The cloud rows are for 2024, the CMA's year; Telefónica's latest archived filing is for 2024.

4.2 Cloud infrastructure

The three US leaders took EUR 42.7 billion of European revenue in 2024: Synergy's market times their share. No source splits it by provider, so it is split by the three segments' worldwide revenue: AWS 45 percent, Microsoft 37, Google 18. Where competition authorities measured the split, AWS weighs more: 65 percent of the three in France in 2021, and 53 percent in the Netherlands in 2020.

The floor is built provider by provider. AWS's part earns its 2024 segment margin, 37.0 percent. Microsoft's part earns 20 percent, the CMA's lowest estimate of Azure's own margin, since its segment also includes server products. Google Cloud's part is left unclassified: the CMA computed no return for it, "as its returns would historically be negative" (§E.12). On these inputs, AWS's and Microsoft's parts earned EUR 10.3 billion of operating income, of which at least 30 percent is rent.

The rent on European cloud revenue was therefore **at least EUR 3.1 billion in 2024**, and at least EUR 5.1 billion at a 10 percent cost of capital. On the French and Dutch splits, the floor is EUR 3.7 billion and 3.6 billion. At most EUR 7.2 billion of the classified income is a normal return. The filings agree with the CMA's floor: AWS's operating income over its total assets was 22.7 percent in 2023 and 25.5 percent in 2024. It fell to 18.1 percent in 2025, after the AI build-out raised its assets by 62 percent. At that return, AWS's 2025 rate is 8.0 cents per euro, against 11.1 on the CMA's floor for 2024.

4.3 The rent across the layers

Table 1. Rent rates on the CMA's definition of capital. Cents of rent in each euro buyers pay, for every holder of Appendix B with a filed income and balance sheet. Group returns come from the latest annual filings, on total assets and on total assets less goodwill; the second feeds the rent share. The cloud rows use the CMA's return floors. The last column is research expense in each euro of revenue, the group's for a segment row; the filings give the research spent, not where it is done.

Layer	Holder	Fiscal year end	Operating margin	Group return: total assets / less goodwill	Rent share	Cents per euro (at 14%; 10%)	Re-search, cents per euro
Accelerators	Nvidia	2026-01	60.4%	63.0% / 70.1%	0.80	48.3; 51.8	8.6
Payment schemes	Master-card	2025-12	57.6%	34.9% / 42.4%	0.67	38.6; 44.0	none filed
Payment schemes	Visa	2025-09	60.0%	24.1% / 30.1%	0.54	32.1; 40.1	none filed
Productivity software	Microsoft, Productivity and Business Processes	2026-06	59.9%	20.5% / 24.3%	0.42	25.4; 35.3	10.7, group
Process equipment	KLA	2026-06	41.7%	31.5% / 35.0%	0.60	25.0; 29.8	11.3
Infrastructure software	Broadcom, group	2025-11	39.9%	14.9% / 34.8%	0.60	23.8; 28.4	17.2
Process equipment	Lam Research	2026-06	35.3%	34.8% / 37.4%	0.63	22.1; 25.9	10.2

Layer	Holder	Fiscal year end	Operating margin	Group return: total assets / less goodwill	Rent share	Cents per euro (at 14%; 10%)	Re-search, cents per euro
Leading-edge fabrication	TSMC	2025-12	50.8%	24.4% / 24.4%	0.43	21.7; 30.0	6.5
Mobile systems, devices and stores	Apple, group	2025-09	32.0%	37.0% / 37.0%	0.62	19.9; 23.4	8.3
Lithography (EU)	ASML	2025-12	34.6%	22.3% / 24.6%	0.43	14.9; 20.5	14.4
Process equipment	Applied Materials	2025-10	29.2%	22.8% / 25.4%	0.45	13.1; 17.7	12.6
PC operating system	Microsoft, More Personal Computing	2026-06	26.6%	20.5% / 24.3%	0.42	11.3; 15.7	10.7, group
Cloud infrastructure	AWS	2024-12	37.0%	CMA: above 20%	0.30	11.1; 18.5	none filed
ERP (EU)	SAP	2025-12	26.1%	13.7% / 23.3%	0.40	10.4; 14.9	18.0
Design software	Cadence	2025-12	28.2%	14.7% / 20.2%	0.30	8.6; 14.2	not archived
Cloud infrastructure	Azure, at the CMA's lowest margin	2024-12	20.0%	CMA: above 20%	0.30	6.0; 10.0	10.7, group
Mobile-network equipment (EU)	Ericsson	2025-12	16.3%	13.8% / 16.6%	0.16	2.6; 6.5	20.6
High-bandwidth memory	Micron	2025-08	26.1%	11.8% / 12.0%	0	0; 4.3	10.2
Arm instruction set	Arm	2026-03	18.3%	8.4% / 9.9%	0	0	56.4
Design software	Synopsys	2025-10	13.0%	1.9% / 4.3%	0	0	35.1
Edge networks	Cloudflare	2025-12	-9.6%	negative	0	0	23.6
Mobile-network equipment (EU)	Nokia, Mobile Networks	2025-12	2.8%	2.4% / 2.8%	0	0	24.4, group

Layer	Holder	Fiscal year end	Operating margin	Group return: total assets / less goodwill	Rent share	Cents per euro (at 14%; 10%)	Re-search, cents per euro
Databases and cloud	Oracle, floor uninformative	2026-05	30.6%	7.9% / 10.3%	0	0; 1.0	15.3
Mobile-network patents (EU)	Nokia Technologies, floor uninformative	2025-12	70.6%	2.4% / 2.8%	0	0	24.4, group
Data-centre switching, no control point	Arista	2025-12	42.8%	19.8% / 20.3%	0.31	13.2; 21.7	13.7
Perimeter security, no control point	Fortinet	2025-12	30.7%	20.1% / 20.6%	0.32	9.8; 15.8	12.0
Data-centre switching, no control point	Cisco	2026-07	24.3%	11.9% / 21.9%	0.36	8.8; 13.2	15.1
Integration, no control point	Accenture	2025-08	14.7%	15.6% / 23.9%	0.41	6.1; 8.5	1.2
Business applications, no control point	Salesforce	2026-01	20.1%	7.4% / 15.3%	0.09	1.7; 7.0	14.4
Perimeter security, no control point	Check Point	2025-12	30.5%	10.6% / 14.1%	0.01	0.2; 8.8	16.8
Access networks, no control point	Telefónica; Vodafone	2024-12; 2026-03	5.8%; 7.0%	2.4% / 2.8%; 2.2% / 2.6%	0	0	none filed; none filed
Servers, no control point	Dell; HPE	2026-01; 2025-10	7.2%; -1.3%	8.0% / 10.0%; negative	0	0	2.8; 7.3
Perimeter security, no control point	Palo Alto Networks; CrowdStrike; Zscaler	2026-07; 2026-01; 2026-07	6.1%; -6.1%; -4.0%	1.4% / 2.6%; negative; negative	0	0	22.2; 28.8; 26.9
x86 processors, no	AMD; Intel	2025-12; 2025-12	10.7%; -4.2%	4.8% / 7.1%; negative	0	0	23.4; 26.1

Layer	Holder	Fiscal year end	Operating margin	Group return: total assets / less goodwill	Rent share	Cents per euro (at 14%; 10%)	Re-search, cents per euro
control point							
<i>Attention and advertising, apart</i>	Google Services, charged with Alphabet-level costs	2025-12	35.8%	21.7% / 23.0%	0.39	14.0; 20.2	15.2, group
<i>Attention and advertising, apart</i>	Meta, Family of Apps	2025-12	51.6%	22.8% / 24.4%	0.43	22.0; 30.4	28.5, group
<i>Attention and advertising, apart</i>	Spotify	2025-12	12.8%	14.6% / 15.8%	0.11	1.4; 4.7	8.1

For Oracle and for Nokia's patent licensing, the group's return measures another business than the layer's: Oracle's capital is dominated by its cloud infrastructure build-out, and patent licensing is 7.5 percent of Nokia's revenue. Their floors are zero and say nothing about the layer; they count as zeros in the medians. Arm's and Micron's returns are below 14 percent on every definition of capital, so their rent on this measure is zero; Micron's year is the upswing of a memory cycle after a year near break-even. KLA tags no operating income in its filing; its figure is revenue less its filed total of costs and expenses.

The rates rank the control points. Three come first: the accelerators, the card schemes and Microsoft's suite, at 25 to 48 cents of each euro. KLA, Broadcom, Lam Research, TSMC and Apple follow at 20 to 25 cents; Broadcom's and Apple's rates use group margins that include their other businesses. Applied Materials is at 13, Microsoft's PC system at 11, the cloud at 6 to 11 cents and the design-software makers at 0 to 9. Cloudflare, which runs at a loss, earns none; Arm and Micron earn less than 14 percent on their capital. Europe's holds earn 0 to 15 cents: ASML 15, SAP 10, Ericsson 3 and Nokia's networks nothing. Counted by position, averaging the holders of each, the median control point earns 10.9 cents, Oracle's and Nokia's zeros included, with the quartiles at 0 and 22.2. Among the 15 control points with a rated finding on substitution (section 3.3), 11 have a measured rate outside the attention layer, with a median of 14.9 cents.

The seven positions without a control point earn a median of 1.7 cents, with the quartiles at 0 and 6.1. The network operators, the server makers and the x86 processor makers earn nothing, Salesforce 2 cents, the five security vendors 2 on average (Fortinet 10, the others 0) and Accenture 6. Cisco and Arista earn 9 and 13 cents in a data-centre switching market that grew by 53.5 percent in 2025 (IDC 2026a). The two distributions overlap. Arista and the switching position as a whole earn more than the median control point, Cisco and Fortinet about as much; five control points earn nothing. With 18 positions against seven, the comparison rests on few observations, and two checks bound it. A one-sided permutation test of the rank sum, exact over the 480,700 ways of drawing seven positions from the 25, puts the chance of a gap at least this large under no difference at 4.6 percent. The gap between the medians also holds under every coding choice at once. Each multi-holder position is represented by each of its holders instead of their mean. The two oligopolies are recoded as competitive, and perimeter security as a control point. Oracle's and Nokia's zeros are left out. Across the 30,720 codings, the gap runs from 9.2 to 13.1 cents. Where the rent is zero, the

gains-from-trade argument of section 1 holds; where several suppliers compete, it holds for most of each euro.

The top of the ranking holds under six tests (Appendix C): the accelerators and the card schemes come first in every one.

- **Each sector's own cost of capital**, 6.5 to 15.4 percent before tax (Damodaran 2026), raises most rates, by up to 6 cents at the control points (Visa) and 8 at Arista. It lowers ASML's by 2 cents, since its sector's cost is above 14 percent. Europe's holds earn 8 to 15 cents.
- **The previous fiscal year** puts the same four holders at the top. Broadcom falls to 8 cents in its first year with VMware, Lam Research to 17, TSMC to 13, and SAP and Ericsson to nothing; Check Point rises to 12 and KLA to 23 at its previous year's return.
- **Five fiscal years**, from the latest annual filing and the three before it, put the card schemes first, at 36 and 32 cents, then Nvidia at 31 and Microsoft's suite at 27. A segment row has the three years of its latest filing, since older filings tag their segments differently. The cyclical holders move most. Nvidia's rate runs from nothing in fiscal 2023 to 51 cents in fiscal 2025, and TSMC's from 7 cents in 2023 to 22 in 2025 with the accelerator build-out. Their averages, 31 and 14 cents, sit well below their latest years. KLA and Broadcom earn 22 and Lam Research 17; Europe's holds earn 13 (ASML), 3 (SAP) and less than 1 (Ericsson).
- **Capitalising research**, which the filings expense, moves the US holders' rates by up to 7 cents, upward where research spending grows fast (Nvidia, Arista, and Broadcom with VMware's research). The card schemes report no research line, so the test leaves them as they are. Europe's holds fall to 0 to 12 cents: they spend more on research for each euro of income, and increase it more slowly. Under the most adverse assumption, research spending flat for ever and depreciating at 15 percent a year, Nvidia keeps 40 cents, TSMC 16, and Lam Research and Microsoft's suite 13 each, while Europe's holds fall to 2 or less.
- **Capitalising organisational capital**, 30 percent of selling, general and administrative expense depreciating at 20 percent a year (Peters and Taylor 2017), moves no rate by more than 3 cents. The largest falls, about 3 cents, are at Cisco, Fortinet, Accenture and Meta, whose selling expense is large against their income; Ericsson's and Salesforce's small rents fall to nothing. The card schemes, SAP, TSMC and the operators file no such line.
- **Keeping goodwill in the capital**, as the CMA's total-assets measure does, lowers the acquirers' rates most: Broadcom to 2 cents, Cadence to 1, and SAP, Ericsson, Cisco and Salesforce to nothing. Europe's holds earn 0 to 13 cents on that measure.

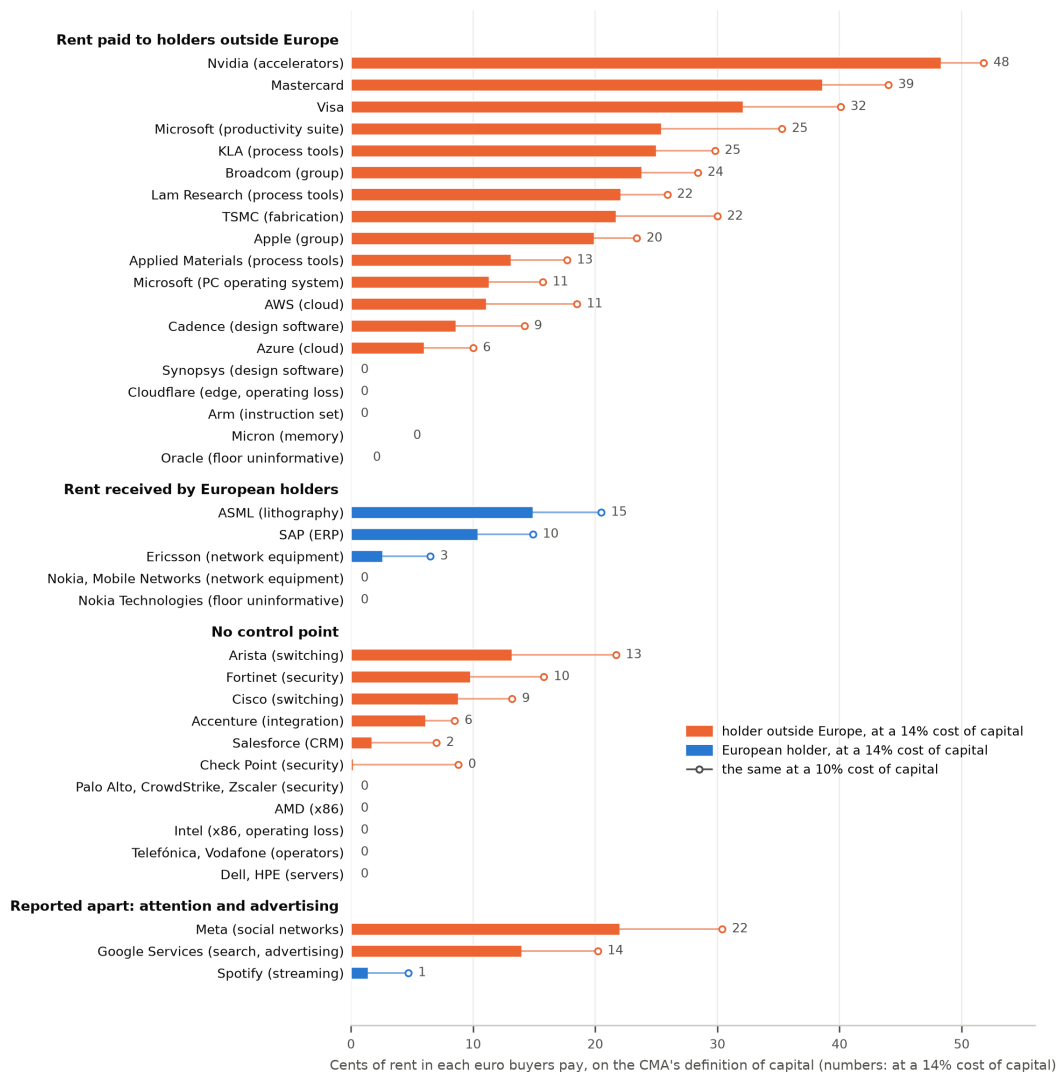


Figure 2. The rent rates of Table 1: cents of rent in each euro buyers pay, on the CMA's definition of capital. The bars use a 14 percent cost of capital, the CMA's benchmark, and the circles use 10 percent. Source: `verify/counterfactual_layers.py`.

4.4 Euro amounts

Euro amounts exist only where a filing gives a European figure, on regions that differ by holder (Apple's includes India, the Middle East and Africa):

- **Cloud:** at least EUR 3.1 billion (section 4.2).
- **Apple:** its Europe segment, which also includes India, the Middle East and Africa, had USD 111.0 billion of revenue in fiscal 2025, for a rent floor of EUR 19.6 billion on the group's margin and return.
- **Broadcom:** its EMEA revenue, chips included, gives a rent floor of EUR 1.9 billion.
- **Visa:** Visa Europe, whose region covers 38 countries including the EU27 and the United Kingdom, had EUR 6.7 billion of operating revenue in the year to September 2025 (Visa Europe [Limited 2025](#)), for a rent floor of EUR 2.2 billion on the group's margin and return. Its own operating margin was 66.7 percent, above the group's 60.0, so the floor is understated.
- **Mastercard:** Mastercard Europe SA, the group's Belgian entity for Europe, books client incentives among its costs, so its turnover of EUR 9.6 billion in 2025 is gross and gives no figure comparable to Visa's (Mastercard Europe [SA 2026](#)). Its own accounts still give

a floor. Its operating profit, after the incentives and the charges it pays to the rest of the group, was EUR 2.6 billion; less a 14 percent return on its total assets, the rent is at least EUR 1.8 billion.

- **Received by Europe from outside it:** ASML takes 98.4 percent of its revenue from outside Europe and the Middle East, a rent floor of EUR 4.8 billion; SAP takes 53.8 percent from outside EMEA, EUR 2.1 billion.
- **Reported apart:** Meta, on its revenue from European advertisers, EUR 9.1 billion.

The paper gives no total. The regions, fiscal years and bases differ, and Microsoft and Nvidia report the United States against the rest of the world, which gives no European figure. The EU's public country-by-country reports list revenue by member state, but that revenue includes intra-group sales booked through the groups' hubs, so it cannot fill the gap.

These amounts measure a narrower object than the best-known European estimate. [Asterès \(2025\)](#) puts European businesses' spending on software and cloud services at about EUR 400 billion in 2024, 83 percent of it paid to US companies, and estimates that EUR 264 billion of it is value added in the United States. Value added pays the wages of the people who do the work, the return on the capital they use, and the rent. At the rates of Table 1, rent takes less than half of each euro at every holder, and 0 to 25 cents at the software and cloud holders of Table 1. The rest of the value added abroad is research, engineering and operations located in the United States. It belongs to capability, the second part of the lead measure (section 7.1), which the rent does not price.

The filings price one input to capability, research. Of each euro buyers pay Nvidia, 48 cents are rent on the CMA's definition of capital and 9 are research; at Microsoft's suite, 25 and 11 (the group's research); at TSMC, 22 and 7. The card schemes file no research line. Europe's holds spend more on research than they earn in rent: ASML 14 cents against 15, SAP 18 against 10, Ericsson 21 against 3, and Nokia 24 against nothing (Table 1). The filings give the research spent, not where it is done. The paper places it at the holder's home, which overstates the research done abroad for the US holders that run laboratories in Europe. And research is an input: the capability it builds, the people and the next product, has no line in a filing.

5. HOW CONTROL SPREADS: BACKING AGAINST THE PAYMENTS

5.1 Payback

When a position grows, it buys more from its suppliers, and they buy more from theirs; each earns its margin on what passes through it. Position i spends a share A_{ik} of its revenue on the output of position k , and position j earns the operating margin m_j on its sales. Per unit of i 's revenue, j earns

$$\psi_{ij} = L_{ij} m_j, \quad L = (I - A)^{-1} - I,$$

where L_{ij} is the share of i 's revenue that reaches j along all payment paths, as in input-output analysis ([Leontief 1936](#)).

Proposition 1 (who backs, and in which direction). For any backing (equity, credits or a partnership) that adds ΔR_i to position i 's revenue, with margins and spending shares unchanged, position j values it at a financial investor's value plus $\psi_{ij}\Delta R_i$. The premium is positive if and only if a payment path runs from i to j through a positive margin. In a stack where every position buys only from positions below it, the backers with a premium all sit below i : backing that pays for itself runs upward, and every such backing closes a loop in which i pays its backer back.

The holders of lower control points therefore value backing the positions that buy from them above what a financial investor would pay, and value it more the more of the position's spending reaches them (Proposition 3). Backing spreads control against the flow

of payments, which runs down the stack. The premium assumes that the backer can serve the extra demand at its margin: the backed position's purchases add to the backer's sales rather than displace another buyer's. Where the backer's capacity is rationed, as leading-edge fabrication and accelerators were from 2023 to 2025, the premium on current sales is near zero, and the motive for backing is the margin on the capacity the backed firm commits to buy later.

Remark (committed purchases). Let the backed position commit to buy K of the backer's future output, deliverable once the capacity exists, as a supply agreement or a warrant that vests on purchases does. The backer's premium is then the margin on the commitment, $m_j K$ discounted to delivery, in place of $\psi_{ij} \Delta R_i$: the same form, on committed rather than current purchases. The direction is unchanged, since only a supplier on the payment path earns a margin on the commitment. The premium then needs no slack capacity today, only capacity by delivery. The financings of section 5.5 are of this kind: none is documented as placed with slack capacity.

5.2 Backing and the scale of the layer above

Backing matters most where research decides what buyers choose. In the single-layer model of *Cheaper and Losing* (Fermigier 2026c), set out in Appendix A, a US entrant with sales elsewhere of M times the EU market and a European entrant spend the same share of their revenue on research. The quality gap follows their relative research budgets, and each year some buyers choose again, weighing quality against a penalty c for a foreign supplier. Write ε for the elasticity of buyers' choice to scale, and λ for the ratio of the two entrants' research rates once their backers return part of their payback as support for research. Without backing, the market is shared when $\varepsilon \leq 1$ when $\varepsilon > 1$, a European presence exists only if $c \geq c^*(\varepsilon, M)$, a threshold in closed form (Lemma 1).

Proposition 2 (backing shifts the scale threshold). (a) If $\varepsilon < 1$, or $\varepsilon = 1$ with an interior steady state, the unique steady-state US share rises with λ . (b) If $\varepsilon > 1$, a European presence exists if and only if $c \geq c^*(\varepsilon, M) + \varepsilon \ln \lambda$: backing that favours the US entrant acts as a fall of $\varepsilon \ln \lambda$ in the penalty for being foreign. (c) In the full dynamics, with each entrant's support any increasing function of its revenue, paid with or without a lag, and with shocks to quality, the path of the US share is pointwise non-decreasing in the US entrant's support.

Over 2,000 random draws of every parameter, US support never lowered the long-run US share. It turned 121 of the 1,663 outcomes with a European presence into a US monopoly (Appendix A).

5.3 Distance

Proposition 3 (payback decays with distance). If the shortest payment path from i to j has d steps, and no position spends more than a share $\bar{\alpha} < 1$ of its revenue on suppliers, then $\psi_{ij} \leq m_j \bar{\alpha}^d / (1 - \bar{\alpha})$.

Distance alone is a weak force. On 2,000 random stacks, a holder three layers below a position earns a median 28 percent of the payback its largest direct supplier earns, and more than the direct supplier where every path funnels through it, as leading-edge chips funnel through lithography. A deep holder's payback is small when the spending share at each step is small. On the AI chain the filings bound those shares:

- the cloud spends at most 75 percent of its revenue on accelerators (AWS's capital expenditure over its revenue);
- the accelerator maker spends at most 29 percent on fabrication (Nvidia's cost of revenue);
- the foundry spends 7 to 12 percent on lithography (ASML's sales to its largest customers over TSMC's revenue).

Per unit of a model developer's revenue, ASML's payback is therefore at most about 2 percent of the cloud provider's: 1.3 percent at the lower lithography share, 2.1 at the upper.

5.4 The evidence

The map's 38 propagation edges test Proposition 1 class by class, since only the equity edges are backing in the proposition's sense.

- **Equity backing.** Six of the seven equity edges run up the stack, each along a coded payment path, which fixes their direction. Four are the cloud's and the accelerator maker's stakes in the model developers, closed and European, and the fifth is ASML's in Mistral AI. The sixth is Nvidia's USD 1.0 billion stake in Nokia, part of a partnership that brings Nvidia's processors into Nokia's radio networks (Nokia 2026): the network-equipment maker pays the accelerator maker that backs it. The seventh, Nvidia's stake in Intel (Intel 2026), is a stake in a processor maker of its own layer, a competitor turned partner, and stays within chip design.
- **Built or integrated.** Of the nine positions holders built or integrated, four run down, four up and one within a layer. The cloud holders' own accelerators, which the Autorité de la concurrence (2024) found "essential" alongside Nvidia's, run down. So do the servers built to their design by contract makers (53.2 percent of server revenue in the fourth quarter of 2025, IDC 2026b), SAP's own data centres beneath its cloud services, and the cloud holders' stakes in subsea cables. Google's own models, Oracle's own cloud infrastructure, Nvidia's own data-centre switching (15.2 percent of the market, IDC 2026a) and Cisco's email filtering run up. The reading that fits is hold-up and supply assurance (Klein, Crawford and Alchian 1978): a holder builds the position it cannot do without, whichever way it lies.
- **Bought.** Of the 14 acquisitions, nine run up, one down and four within a layer (Table B2, Appendix B), and half of them enter the two competitive positions that every customer buys: security and integration. Cisco bought Splunk, "a recognized leader in security analytics and observability", as part of "infusing security into the fabric of the network" (Cisco 2025); Telefónica and Vodafone bought cloud integrators. The reading is envelopment, a holder entering an adjacent market through the customers it shares with it (Eisenmann, Parker and Van Alstyne 2011). The other acquisitions take a position next to the buyer's own. Broadcom bought VMware, whose virtualisation software its adapters must work with; the Commission cleared that deal on commitments that VMware's software keep working with the adapters of Marvell, Broadcom's only rival (European Commission 2023c). Microsoft bought LinkedIn, cleared on commitments (European Commission 2016), and AMD the server designer ZT Systems and the Finnish AI laboratory Silo AI (AMD 2026). Within a layer, the card schemes bought account-to-account payment businesses, the alternative to cards: Mastercard bought Nets', cleared on a licence remedy (European Commission 2020), and Visa bought Tink; Salesforce bought Slack (Salesforce 2026). Payback explains none of the 23 positions built or bought. The paper does not claim it does.
- **Bundling, licensing and terms.** Seven of the eight extensions of an installed base run up by the order of the layers and one stays within a layer. They are Windows into the suite, the suite into the assistant and into security products, the server system's licences into the cloud, and the cloud's licences into SAP's sovereign cloud and its partner programmes into the integrators. The last two are the store's terms onto Spotify, and Android's licence terms into search, the tying the Commission fined and the General Court upheld (European Commission 2018; General Court of the European Union 2022). Three of the seven upward directions are fixed by a payment path; the other four depend on the order of layers between which no payment is coded. Three of the eight edges run between two positions of the same holder: Windows and the suite, the server system and Azure, Android and search.
- **Direction, in sum.** Of the 38 edges, 26 run up, 5 down and 7 within a layer, and 19 of the 31 directed edges have their direction fixed by the payments. Control runs up where

the payments pay the backer back, as Proposition 1 predicts, and where an installed base is extended; it runs down where a holder builds its own supply. The acquisitions into security and integration owe their direction to the order of the layers more than to the payments: four of their six directions rest on convention.

- **Loops.** Six loops close. The cloud holds equity in the model developers, which pay it for computing. The mobile systems' holders extend into search, whose holder pays them for the default. The cloud licenses its technology to SAP's sovereign cloud, while SAP pays the hyperscalers to deliver part of its services. The accelerator maker invests in the model developers, whose computing bills reach it through the cloud's capital spending. It also invests in Mistral AI, which builds its own computing platform on Nvidia's GPUs (Mistral AI 2025a), and in Nokia, which brings Nvidia's GPUs into its radio networks.

In cloud, the loop's size is bounded in part. Microsoft holds about 25 percent of OpenAI, had funded USD 11.9 billion of its USD 13.0 billion commitment by June 2026, and recorded USD 24.1 billion of revenue "from commercial arrangements with OpenAI, inclusive of revenue-sharing payments" in fiscal 2026 (Microsoft 2026). The filing does not separate the computing sold from the revenue share received, the terms of the computing are not public, and part of it would have been bought from Azure without the stake. On the computing, the part Proposition 1 prices, the margin is at most USD 4.8 billion a year at the 20 percent used for Azure in section 4 and at most USD 9.95 billion at the operating margin of Microsoft's whole cloud segment; net of a 14 percent return on the capital that serves it, at most USD 1.4 to 6.9 billion, which would cover the funding in 1.7 to 8.2 years. The revenue share, undisclosed, comes on top at close to full margin. Microsoft's share of OpenAI's losses, booked under the equity method, is not netted here. The credits the providers offer start-ups (section 3.4) are the same mechanism at a smaller scale: backing, larger at the larger holders, repaid in the computing the start-up will buy.

5.5 The prediction and its cases

Proposition 1 predicts which positions a holder backs, in a form a reader can refute. A holder of a control point backs the positions whose purchases reach it through a payment path, more the larger the share of their spending that reaches it and the slacker its capacity. A stake in a position that does not pay its holder is hold-up, supply assurance or a portfolio holding, and payback does not explain it. A pattern of stakes by holders of control points in positions with no payment path back, while the positions that pay them go unbacked, would refute it.

Table 2 lists every financing the sources document between a holder of a mapped position and a position or a layer of the map: 17 in all, from the census of section 3.3, the authorities' decisions and the developers' announcements. 12 of the 17 financings run along a documented payment path back to the backer, and 10 of the 15 stakes by holders of control points do. The benchmark is the map itself: of the 1,482 ordered pairs of its 39 positions, 37 have a payment path from the first to the second, 2.5 percent. A placement of 17 financings blind to the paths would reach 12 with a probability of the order of 10^{-16} on a binomial count. The financings are not independent draws, so that figure is an order of magnitude rather than a test statistic; the result is the gap between 71 and 2.5 percent. The reading column says which of the 12 the paper reads as payback and what the five without a path are instead.

Table 2. The financings between the map's holders, and the payment paths back.

Every financing a filing, an authority's decision or an announcement documents between a holder of a mapped position and a position or a layer of the map. "On the map" counts the coded payment edges from the backed position back to the backer; otherwise the path is the documented purchase. Source: data/map/financings.csv, read by verify/architecture_model.py.

Backer → backed	Instrument and amount	Payment path back to the backer	Reading
Microsoft (cloud) → OpenAI (closed models)	equity (about 25 percent as converted); USD 13.0bn committed, 11.9bn funded (Microsoft 2026) [B]	on the map, 1 step	payback
Amazon (cloud) → Anthropic (closed models)	convertible notes, part converted to non-voting preferred stock; USD 8.0bn (5.3bn in 2023 and 2024; 2.7bn in 2025) (Amazon 2026) [B]	AWS supplies Anthropic's compute and is its primary cloud provider (CMA 2024b)	payback
Google (cloud) → Anthropic (closed models)	non-voting shares and convertible notes (CMA 2024a) [A]	Google supplies compute to Anthropic (CMA 2024a)	payback
Microsoft (cloud) → Mistral AI (European models)	convertible bond and Azure partnership; EUR 15m (Autorité de la concurrence 2024) [A]	none documented: the partnership gives access to Azure's supercomputers, on terms not made public	undetermined: the terms that would show which way the payments run are not public
Nvidia (accelerators) → OpenAI (closed models)	investment and partnership agreement being finalised (Nvidia 2026) [B]	on the map, 2 steps	payback on the capacity committed
Nvidia (accelerators) → Mistral AI (European models)	equity in the September 2025 round (Mistral AI 2025b) [C]	on the map, 1 step	payback on the capacity committed
ASML (lithography) → Mistral AI (European models)	equity, 11.1 percent, lead investor; EUR 1.3bn (ASML 2026) [B]	on the map, 3 steps	not payback: along a path through three other holders, the payback is at most about 2 percent of the cloud's
Nvidia (accelerators) → Intel (x86)	common stock (215 million shares); USD 5.0bn (Intel 2026) [B]	none coded: the partnership co-develops products combining Intel's x86 processors with Nvidia's computing (Intel 2026)	not payback: a product partnership within chip design
Nvidia (accelerators) → Nokia (network equipment)	equity, directed share issue; USD 1.0bn (Nokia 2026) [B]	on the map, 1 step	payback
Nvidia (accelerators) → CoreWeave (cloud layer)	Class A common stock; USD 2.0bn (CoreWeave 2026) [B]	all the GPUs in CoreWeave's infrastructure are Nvidia's (CoreWeave 2026)	payback
AMD (x86) → OpenAI (closed models)	warrant for up to 160 million shares vesting with OpenAI's purchases of AMD's GPUs (AMD 2026) [B]	the warrant vests on OpenAI's purchases of AMD's Instinct GPUs (AMD 2026)	payback: a rebate in shares on the buyer's purchases
STMicroelectronics (chip design) → AWS (cloud)	warrants for up to 24.8 million shares vesting with AWS's purchases of ST's products (STMicroelectronics 2026)	the warrants vest with AWS's payments for ST's products (STMicroelectronics 2026)	payback: a rebate in shares on the buyer's purchases

Backer → backed	Instrument and amount	Payment path back to the backer	Reading
	croelectronics 2026) [B]		
AWS, Microsoft, Google (cloud) → start-ups (start-ups)	cloud credits; USD 100,000 to 200,000 per start-up (Autorité de la concurrence 2023) [A]	the start-ups buy their computing from the provider	payback
Nokia (network equipment) → Nscale (cloud layer)	partnership and investment (Nokia 2026) [B]	investments in sovereign AI cloud providers such as Nscale “ensure our solutions are embedded” (Nokia 2026)	payback
Arm (instruction set) → Ampere (chip design)	equity (6.5 percent) and a convertible loan, sold in 2025; USD 0.18bn of proceeds (Arm 2026) [B]	none documented in the filing	undetermined: the filing documents no payments between the two; the stake was sold in 2025
Oracle (databases) → Ampere (chip design)	equity-method investment, debt and call options, sold in 2025; USD 4.3bn of proceeds (Oracle 2026) [B]	none documented in the filing	not payback: no payment path back is documented; the stake was sold in 2025
Meta (social networks) → Scale AI (AI-model layer)	non-marketable equity investment (Meta 2026) [B]	none documented in the filing	not payback: no payment path back is documented

Three cases depart from the simple form.

- **ASML’s stake in Mistral AI** has a path back, three holders long, through Nvidia and the foundry. Along it ASML’s payback is at most about 2 percent of the cloud provider’s, and no larger than from any other model developer (section 5.3). On so small a share, payback cannot explain an 11.1 percent stake for EUR 1.3 billion as lead investor.
- **Nvidia’s stake in Intel** is in a competitor of its own layer, for a partnership that co-develops products combining Intel’s x86 processors with Nvidia’s computing ([Intel 2026](#)). No coded payment runs from Intel to Nvidia, and the stake reads as a product partnership.
- **Warrants issued to buyers** reverse the direction of the shares. AMD issued OpenAI a warrant for up to 160 million shares that vests as OpenAI buys AMD’s GPUs ([AMD 2026](#)), and STMicroelectronics issued AWS warrants that vest with AWS’s payments for its products ([STMicroelectronics 2026](#)). The supplier finances the buyer’s purchases with a rebate paid in shares: the mechanism of Proposition 1, with the shares flowing to the backed firm. The test of the mechanism is the payment path, whichever way the shares go.

Two conditions of the proposition show in the filings. The spending share matters: per unit of a model developer’s revenue, the accelerator maker’s payback is at most 1.1 times the cloud provider’s, and ASML’s at most 2 percent of it (section 5.3), so the backers of the model developers are the cloud holders and the accelerator maker, and lithography is the exception. And capacity was rationed when most of these stakes were placed: Nvidia’s filing describes a “supply-constrained environment”, and Microsoft’s its own “infrastructure capacity constraints” ([Nvidia 2026](#); [Microsoft 2026](#)). The premium is then on the capacity the backed firms commit to buy, the case of the remark in section 5.1. No stake in Table 2 is documented as placed with slack capacity. Two cases stay undetermined: the terms of Microsoft’s partnership with Mistral AI, which gives Mistral access to Azure’s supercom-

puters, are not public (Autorité de la concurrence 2024), and the filing records no payments between Arm and Ampere.

6. WHAT OPENING DOES

6.1 Complements bought side by side

A product needs one unit of each of several components. A closed component is held by one firm, which sets its price; an open component is sold at cost by competing providers. Demand is $D(P)$, with P the sum of the prices, and C is the sum of the components' costs. Let $h(P) = D(P)/(-D'(P))$ and $\Pi(P) = (P - C)D(P)$, and write P_n for the equilibrium price with n closed components.

Lemma 2 (equal markups). In equilibrium every holder takes the markup $h(P)$, whatever its cost, and P_n solves $P - C = n h(P)$.

The results hold under two conditions: a single equilibrium price for each n , rising with n , and industry profit not increasing above the single-holder price. Both hold when demand is log-concave, and with a constant elasticity $e > n$, where the equilibrium exists.

Proposition 4 (opening helps the buyers and the remaining holders). Opening one of $n \geq 2$ closed components lowers the price, raises the quantity and raises each remaining holder's profit. Each holder's markup rises if demand is strictly log-concave, stays unchanged if demand is exponential, and falls if demand is log-convex, in which case the holders gain on volume.

Proposition 5 (value moves to the next control points). The remaining $n - 1$ holders take at least as much, in total, as all n took before the opening. With linear demand, each remaining holder's profit rises by the factor $((n + 1)/n)^2$.

Proposition 6 (who gains, by jurisdiction). Let n_F of the n closed components be held abroad. Opening a component held in Europe raises the foreign holders' rents. Opening a component held abroad lowers them if and only if $n_F < 1/(1 - \pi_n/\pi_{n-1})$, with π_n each holder's profit with n closed components; with linear demand the bound is $(n + 1)^2/(2n + 1)$, about $n/2 + 3/4$.

Proposition 5 is the anticommons result read in reverse: removing a holder of a complementary right raises the rents of the others. In the 4,000 random draws of the reproduction script, covering six demand families and two to six closed components, Propositions 4 and 5 hold in all 3,951 draws with a single equilibrium. The other 49 draws, markets that mix price-sensitive and price-insensitive buyers, have two equilibria; the propositions do not apply to them. The bound of Proposition 6 depends on the shape of demand. As a share of the number of closed components, its median is 0.53. The more elastic the demand, the fewer foreign holders it takes for an opening abroad to raise the rents captured abroad.

6.2 Vertical chains

Most of the stack is a chain: lithography supplies fabrication, which supplies the accelerator makers, who supply the cloud. Each holder buys from the one before it and marks up the price it pays.

Proposition 7 (opening along a vertical chain). With linear demand and n holders in sequence, output is $(a - C)/2^n$ and the k -th holder, counting from the most upstream, takes the markup $(a - C)/2^k$. Opening any one holder's position at least doubles every remaining holder's profit and raises the total. With two holders, the total rises under any demand: the holder that remains is a monopolist on the whole chain, and earns at least the joint profit of the two before.

The closed form matches a brute-force backward induction within the precision of the search, and openings found by the same search double every remaining profit. Beyond linear demand, a Monte-Carlo check drew 300 chains of three holders, with random costs and

linear, power, exponential or shifted constant-elasticity demand, and opened one holder at random. In all 300, every remaining holder's profit rose, and output and the total rose with it. The smallest rise was 48 percent, so the doubling is specific to linear demand. Each upstream holder's price is found by a grid scan of its profit, which need not be single-peaked under these demands, refined by golden-section search in the best cell; the grid found more than one local peak in one draw.

6.3 Opening the cloud

Suppose the cloud's control points opened: managed services made portable, and data moved at cost, the direction in which the EU Data Act points for switching charges from 12 January 2027 (European [Parliament and Council 2023](#)). Both structures apply. Beside the cloud, the buyer pays for licensed software and model services, all held in the United States; with linear demand, opening the cloud raises each of those two holders' rents by 78 percent and the rents held abroad by 18.5 percent in total. Along the chain below it, every remaining holder's profit at least doubles. In the model's four-holder chain (lithography in Europe, fabrication in Taiwan, accelerators and cloud in the United States), the rents held outside Europe rise by 71 percent and lithography's double. Those two ratios follow from the model's split of profits, which puts the largest profits upstream. The filings do not support that split (section 5.3). The robust part is the direction: opening the cloud raises the rents of the remaining holders, almost all held abroad.

6.4 Europe's holds

The same logic applies to Europe's own control points. Opening lithography, or making ERP data and customisations freely portable, would lower prices for the buyers and raise the rents of the adjacent holders: the foundries (Taiwan) and the other equipment makers (United States) for lithography, the hyperscalers (United States) for ERP. Opening moves value to the next control points whoever holds the opened one.

7. ALTERNATIVE ARCHITECTURES, MEASURED BOTH WAYS

7.1 Two measures

A loss is measured against an alternative architecture, on two measures:

- **Value captured abroad and capability.** The rents paid to holders outside Europe, the research and skills located with them, and the positions they finance. Table 1 gives the rent and the research in each euro a number; the skills and the positions financed have none. The paper leads with this measure, because producing and using differ on it. A holder's home is where its headquarters and control sit; its shareholders abroad receive part of its rent, as European shareholders receive part of US holders', and the measure does not trace them.
- **The European buyers' welfare.** When a layer's price falls, buyers recover the rent shifted to them, plus the deadweight loss the higher price caused. This is the measure the gains-from-trade argument uses.

Three alternatives are set against the measured architecture:

- **A European holder.** The same architecture, with the control point held in Europe. Value captured abroad falls by the layer's rent, and buyers pay the same prices. The holder's research and skills move to Europe, and so do its backing decisions and their payback. Backing stays blind to nationality, though, so a European holder does not by itself anchor capability in the layers that buy from it (section 8).
- **A contested control point,** where a rival at scale competes for the position.
- **An open interface,** where the position is sold at cost by competing providers.

In the last two, the layer's rent competes down, in full at an open interface and in part under a duopoly; buyers recover what competes down, with its deadweight loss, and the remaining holders' rents rise (section 6).

7.2 Cloud, worked out

Table 3. Cloud infrastructure, 2024: the alternatives measured both ways.

Alternative	Value captured abroad	European buyers
A European holder	falls by the rent, at least EUR 3.1 billion a year	no change
A contested control point or an open interface	the cloud's rent competes away; the rents of the adjacent holders, almost all abroad, rise	recover between 0.4 and 1.5 times the opened rent, dead-weight loss included

How much buyers gain depends on where the opened position sits. In a linear vertical chain, buyers gain the same amount whichever link opens, since output doubles in every case; relative to the opened link's rent, the gain is 1.5 times for the last link and 0.75 times for the third of four. For one of three complements bought side by side, it is 0.39 times. The cloud is both the last link of the chain that ends with it and one of the complements its buyers combine with software and models. With linear demand, opening or contesting it gives European buyers between 0.39 and 1.5 times the cloud's rent, depending on which structure dominates. At the upper end, buyers gain more than the rent a European holder would keep in Europe; at the lower end, less. Both ratios rest on the model's split of profits (section 6.3). By the measure of value captured abroad, opening does worse, since the adjacent holders' rents rise.

A contest that ends in a duopoly leaves buyers less than an open interface. Along the chain with linear demand, a Cournot duopoly at the contested link passes a derived demand upstream whose slope is 1.5 times the final demand's, where a monopolist's is 2. Output and the profits of the holders upstream of the link then rise by a third, where opening doubles them, and the two duopolists together keep half a monopolist's markup. At the last link, buyers gain 0.39 times the link's rent against 1.5 under an open interface, about a quarter of the opening gain. Beside complementary components the duopoly case depends on the form of competition: two sellers of an identical component who price against each other reach the open case, and quantity competition needs an order of moves the model does not fix.

7.3 The other layers

Table 4. The alternatives across the layers. The adjacent positions come from the map's edges.

Layer	A European holder: value captured abroad	Opening or contest: who else gains
Accelerators (Nvidia)	falls by the rent, 48 cents per euro on the CMA's definition of capital	fabrication (Taiwan) upstream; the cloud (United States), the closed model developers (United States) and Mistral AI (EU) downstream
Payment schemes (Visa, MasterCard)	falls by 32 to 39 cents per euro	no complement mapped; the one edge leads to a substitute, account-to-account payments, where the schemes bought Nets' business and Tink
Productivity software (Microsoft)	falls by 25 cents per euro	the same holder's PC operating system; the model developers

Layer	A European holder: value captured abroad	Opening or contest: who else gains
Infrastructure software (Broadcom)	falls by up to 24 cents per euro, on the group's margin	and the security products it bundles (United States) Broadcom's own adapters, which VMware's software must work with (United States); the exit routes are the public cloud (United States) and the open-source stack, where European suppliers sit
Mobile systems and stores (Apple)	falls by 20 cents per euro, the whole group's rent	Google's search, which pays for the default (United States); the app developers, Spotify (EU) among them

Where the holder of the opened position also holds the adjacent ones, buyers may gain nothing. A firm holding several components prices them together, and with fixed proportions it can raise the price of the components it keeps by the margin it loses. Microsoft's suite beside its PC operating system is the case the map shows.

8. EUROPE'S POSITION: VALUE WITHOUT CAPABILITY

Europe holds four of the stack's 27 control points, and on three of them the rent can be measured: ASML earns 15 cents per euro, SAP 10, and the network-equipment makers 3 (Ericsson) and nothing (Nokia). They spend 14, 18, 21 and 24 cents of each euro on research (Table 1), and their buyers are largely outside Europe. ASML takes 98.4 percent of its revenue from outside Europe and the Middle East, a rent floor of EUR 4.8 billion a year; SAP takes 53.8 percent from outside EMEA, a floor of EUR 2.1 billion. Counting research as capital, or keeping goodwill in the capital, lowers both, SAP's to nothing (Appendix C). Nokia earns a 70.6 percent operating margin on its patent licences, against 2.8 percent on its mobile networks.

These holds earn value without anchoring an industry in the layers that use them, for three reasons.

1. **The demand is elsewhere.** ASML sold 1.6 percent of its 2025 revenue in Europe and the Middle East, against 29.1 percent in China, 25.5 in Taiwan and 25.0 in South Korea. Its public-affairs head said in September 2026: "We are selling absolutely nothing in Europe [...] Because Europe is not investing and because no chip factories are being built in Europe" (Shilov 2026).
2. **Backing is blind to nationality.** A holder earns its margin on the growth of whichever downstream grows, so it has no payback reason to prefer a European one. Along the AI chain, every link between a European model developer and lithography is held outside Europe, and ASML's payback from that developer's growth is at most about 2 percent of the cloud provider's (section 5.3). The backers with a payback motive are the US cloud and accelerator holders, which take stakes in European developers as in American ones.
3. **The holder depends on control points held abroad.** SAP implements part of its cloud services through the hyperscalers. Its sovereign offer for the German public sector licenses Microsoft's cloud.

Two of the 38 propagation edges leave a European control point: ASML's stake in Mistral AI, and SAP's own data centres beneath its cloud services, a build that runs down to a layer SAP also buys from the hyperscalers. Seven end at European positions. Four end at the European model developers: the cloud's, the accelerator maker's and ASML's stakes in Mistral AI, and AMD's purchase of Silo AI. The others end at SAP, at Spotify, and at Nokia's network

equipment, through Nvidia's stake. One European holder backs upward along its payments: Nokia invested in Nscale, a British AI cloud provider, to "ensure our solutions are embedded" (Nokia 2026; Table 2). European operators also take positions above them: Telefónica and Vodafone bought cloud integrators. European capital also earns abroad. Deutsche Telekom holds 52.8 percent of T-Mobile US, whose operating income of USD 18.3 billion in 2025 exceeded Telefónica's and Vodafone's together.

9. READING FOR POLICY

No instrument is evaluated: the alternatives are architectures. On the two measures, they do the following.

- **Opening a layer, or contesting it, helps European buyers.** In the cloud, buyers recover between 0.4 and 1.5 times the rent a European holder would keep in Europe when the layer opens, depending on the market's structure, and about a quarter of that when a contest ends in a duopoly (section 7.2). Unless demand is so concave that the remaining holders' profits barely rise, opening does not lower the value captured abroad where the adjacent control points are held abroad, which is the case along most of the stack.
 - **A European holder lowers the value captured abroad by the layer's rent.** It leaves prices unchanged. It does not by itself bring capability to the layers above, since backing follows payback, whatever the backed firm's nationality.
 - **Opening Europe's own holds moves value abroad,** to the holders adjacent to them.
- Remedies that serve buyers differ from remedies that keep value and capability in Europe, so an assessment of a remedy should say which measure it serves.

10. LIMITS

1. **The rents are stated on the capital the CMA counts, and cannot separate three readings.** The bases keep cash, acquired intangibles and current liabilities, which understates the rent, and leave out the research and selling expense the holders write off, which overstates it. Capitalising research moves the US holders' rates by a few cents and lowers Europe's holds; capitalising organisational capital moves no rate by more than 3 cents; keeping goodwill in the capital lowers the acquirers' (Appendix C). Each sector's own cost of capital leaves the top of the ranking as it is. No test separates a rent from the control point, a quasi-rent on an innovation that competition has not caught up with, and the return on capital the accounts miss (section 4.1); the paper ties the excess to the position by its structural coding. The rates are for one fiscal year, tested on the previous one and averaged over five (three for the segment rows). Five years cover at most one accelerator cycle: Nvidia's rate runs from nothing in fiscal 2023 to 51 cents in fiscal 2025; its five-year average, 31 cents, is two-thirds of its latest year's. The research of Table 1 is each group's, placed at its home.
2. **European figures are few.** Euro amounts exist for eight holders, and for Meta apart, on different regions and years, and the paper gives no total.
3. **The map is incomplete.** Every control point is sourced. The propagation edges are checked against a census of the archive's 88 annual filings, which cannot see what a filing does not name: stakes below the filer's materiality threshold (Nvidia's in Mistral AI rests on the developer's announcement), deals agreed after the filing date, the annual report that Ericsson's filing incorporates by reference, and, in a list of acquired firms, a name the reading does not reach unless it belongs to a mapped holder. A position-taking in a layer the map does not split into positions is not an edge: the census finds 144 such counterparties, among them Alphabet's agreed purchase of Intersect, a data-centre and energy developer, and Nvidia's stake in CoreWeave, a GPU cloud, which

Table 2 lists. Alphabet’s agreed purchase of Wiz was pending in its 2025 filing and is not coded. Twelve of the 27 control points have no rated finding on their substitution cost. Skills are measured at one control point, from a self-selected survey, and habits at none. The edge networks’ position rests on the paper’s own measurement alone, and 12 of the 31 directed propagation edges owe their direction to the order of layers between which no payment is coded.

4. **The propositions are stylised.** The opening results assume fixed proportions and distinct holders. A contested control point is modelled as one priced at cost, the limit of a contest, and along the chain as a Cournot duopoly, which leaves buyers about a quarter of the opening gain (section 7.2); beside complements, the duopoly case is not modelled. Proposition 7 is proved for linear demand and for two holders under any demand. For three holders under other demand shapes it rests on a Monte-Carlo check over four demand families, three of them non-linear, in which profits rose by less than the linear doubling; longer chains are proved for linear demand only. Proposition 1 prices backing by its payback alone, at an unchanged margin on sales that add to the backer’s: the map also records other motives, protecting a rent below (Broadcom’s purchase of VMware), buying a substitute (the card schemes’ purchases), securing supply (the cloud holders’ own accelerators and servers) and entering an adjacent position through shared customers (the acquisitions into security and integration), which the model leaves out, and the rationed-capacity case in which the premium is on future capacity (section 5.1).
5. **The time path is outside the paper.** How options and exit costs evolve as control spreads, and how the capture loop compares with a planner’s choice, belong to a dynamic analysis that this paper does not attempt.

11. CONCLUSION

The digital stack costs Europe the rents at a few control points, the capability those rents finance, and control over the products’ evolution. Measured as floors, the rents are large at the accelerators, the card schemes and the productivity suite, smaller in the cloud, and low or nil where several suppliers compete. Backing spreads control up the stack against the payments, because the holders below a position are paid back by its growth; where holders build their own supply, control runs the other way, and their acquisitions enter the competitive positions every customer buys. Opening a control point helps buyers, and moves the rent to the next one. Europe’s own holds earn value from outside Europe without anchoring the layers above them. Opening serves European buyers; a European holder keeps the rent in Europe. The two measures rank the remedies differently.

APPENDIX A. PROOFS

The single-layer model of section 5.2. In a single layer, a US entrant with an EU market share s and sales elsewhere of M times the EU market competes with a European entrant. The EU market is normalised to 1, so when each spends the same share of its revenue on research, the two research budgets are $B_U = s + M$ and $B_E = 1 - s$. The quality gap g follows the relative budgets and erodes by diffusion: $g_{t+1} = \rho g_t + \theta \ln(B_U/B_E)$, with $\rho < 1$ the persistence of a lead and θ the response of quality to relative research. Each year a share δ of buyers re-chooses, picking the US entrant with the logistic probability $\Lambda(ag_t - c)$, where a is the value of quality and c the penalty a foreign supplier faces: $s_{t+1} = (1 - \delta)s_t + \delta \Lambda(ag_t - c)$. Write $\varepsilon = a\theta/(1 - \rho)$ for the elasticity of buyers’ choice to scale. Lemma 1 gives the steady states.

Let each entrant’s backers return part of their payback as support for its research, so that the budgets become $B_U = (s + M)(1 + \kappa_U)$ and $B_E = (1 - s)(1 + \kappa_E)$, and write $\lambda = (1 + \kappa_U)/(1 + \kappa_E)$ for the ratio of the two entrants’ backed research rates.

Over 2,000 random draws of every parameter, US support never lowered the long-run US share, as part (c) of Proposition 2 predicts. In 121 of the 1,663 draws that end with a European presence without support, the support turned the outcome into a US monopoly.

Lemma 1 (the single layer). Write Λ for the logistic function, $\varepsilon = a\theta/(1 - \rho)$, and $G(s) = \ln s - \varepsilon \ln(s + M) - (1 - \varepsilon) \ln(1 - s)$. The steady states solve $\text{logit}(s) = \varepsilon \ln \frac{s+M}{1-s} - c$, that is $G(s) + c = 0$. (a) If $\varepsilon < 1$, there is one steady state, stable, rising with M and falling with c if $\varepsilon = 1$, the same holds when $c > \ln(1 + M)$, and monopoly attracts otherwise. (b) If $\varepsilon > 1$, monopoly is always an attractor. An interior steady state exists if and only if $c \geq c^*(\varepsilon, M) = \ln(1 + M) + \varepsilon \ln \varepsilon + (\varepsilon - 1) \ln \frac{M}{\varepsilon - 1}$.

Proof. (a) $G'(s) = 1/s - \varepsilon/(s + M) + (1 - \varepsilon)/(1 - s) > 0$, and G runs from $-\infty$ to $+\infty$ when $\varepsilon < 1$, so $G + c$ has one root, crossed upwards. At $\varepsilon = 1$, G rises from $-\infty$ to $-\ln(1 + M)$, so the root exists if and only if $c > \ln(1 + M)$. $\partial G/\partial M < 0$ moves it up as M rises, and raising c moves it down. (b) For $\varepsilon > 1$, $G \rightarrow -\infty$ at both ends, and $G' = 0$ has the single solution $s_c = M/(\varepsilon(1 + M) - 1)$, so G is single-peaked; near $s = 1$, $G + c < 0$ and the corner attracts. An interior root exists if and only if $\max G + c \geq 0$, and $-G(s_c) = c^*$. ■

Proposition 1. *Proof.* j 's operating income rises by m_j times the extra sales that reach it, which are $L_{ij}\Delta R_i$ by the definition of L . $L_{ij} = \sum_n (A^n)_{ij} > 0$ if and only if a path of purchases runs from i to j . If every position buys only from below, A is strictly lower-triangular in an ordering by layer, and so are its powers, so $L_{ij} = 0$ whenever j is not below i . ■

Proposition 2. *Proof.* (a, b) In the steady state, $\ln(B_U/B_E) = \ln \frac{s+M}{1-s} + \ln \lambda$, so $\text{logit}(s) = \varepsilon \ln \frac{s+M}{1-s} - (c - \varepsilon \ln \lambda)$, which is Lemma 1 with c replaced by $c - \varepsilon \ln \lambda$. (c) The map from (g_t, s_t) to (g_{t+1}, s_{t+1}) is non-decreasing in each argument: B_U rises and B_E falls with s when supports increase with revenue, Λ is increasing, ρ is positive, and g_{t+1} rises with the US entrant's support. By induction on t , two paths from the same state under the same shocks, one with more US support, stay ordered; a lag adds past shares to the state and changes nothing. ■

Proposition 3. *Proof.* $(A^n)_{ij} = 0$ for $n < d$. For $n \geq d$, every entry of the non-negative matrix A^n is at most its largest row sum, $\|A^n\|_\infty \leq \bar{\alpha}^n$. Summing over $n \geq d$ gives the bound. ■

Lemma 2. *Proof.* Holder k maximises $(p_k - c_k)D(P)$. The first-order condition $D(P) + (p_k - c_k)D'(P) = 0$ gives $p_k - c_k = h(P)$, and summing over the closed components gives $P - C = n h(P)$. ■

Propositions 4 and 5. *Proof.* When D is log-concave, h does not increase, so $P - C$ and $n h(P)$ cross once, further up as n grows: $P_{n-1} < P_n$. And $\Pi'(P) = (-D'(P))(h(P) - (P - C)) \leq 0$ for $P \geq P_1$. Hence $\Pi(P_{n-1}) \geq \Pi(P_n)$: the remaining holders' total, $R(n-1) = \Pi(P_{n-1})$, is at least $R(n)$. Each holder earns $\pi_{n-1} = \Pi(P_{n-1})/(n-1) > \Pi(P_n)/n = \pi_n$. The markup follows the monotonicity of h . With a constant elasticity e , $h(P) = P/e$, and $P - C = nP/e$ has the single root $P_n = C/(1 - n/e)$ when $e > n$, rising with n . Π is single-peaked at P_1 , and the same argument applies. With linear demand, $P_n = (C + na)/(n+1)$ and $\pi_n = (a - C)^2/(n+1)^2$. ■

Proposition 6. *Proof.* Opening a European-held component leaves n_F foreign holders, each earning $\pi_{n-1} > \pi_n$. Opening a foreign-held one lowers the foreign rents if and only if $(n_F - 1)\pi_{n-1} < n_F\pi_n$, which rearranges to the bound; with linear demand, $\pi_n/\pi_{n-1} = n^2/(n+1)^2$. ■

Proposition 7. *Proof.* By induction from the most downstream holder. Buying at w , it sells $(a - w - c_n)/2$, so it presents its supplier with an inverse demand of twice the slope; each step upstream doubles the slope again, and the k -th holder from the most upstream faces slope 2^{n-k} . Its markup is $(a - C)/2^k$, and output is $(a - C)/2^n$. Opening a holder's position leaves a chain of $n - 1$, in which output doubles. The holders upstream of the opened one keep their markups; those downstream move up one place, so their markups double. The total goes from $(a - C)^2(1 - 2^{-n})/2^n$ to $(a - C)^2(1 - 2^{1-n})/2^{n-1}$, a ratio of $(2^{n+1} - 4)/(2^n - 1) > 1$ for $n \geq 2$. With two holders and any demand, the remaining holder sets the whole chain's price and earns $\max_P \Pi(P) \geq \Pi(p)$ at any price p , in particular the joint profit before. ■

APPENDIX B. THE POSITIONS OF THE MAP

Table B1. The map in numbers. Source: `verify/architecture_map.py` and `verify/edge_census.py`.

Item	Count
Positions	39: 27 control points, 10 competitive, 2 run publicly or by a non-profit
Control points by home	US 19; EU 4; CN 1; TW 1; UK 1; KR 1
Substitution cost of the control points	9 findings, 2 designations, 4 concerns; 12 not measured
Edges	66: 38 propagation, 12 payment, 16 reach
Equity backing	6 up; 0 down; 1 same level
Make or buy	13 up; 5 down; 5 same level
Bundling, licensing and terms	7 up; 0 down; 1 same level
Direction of the directed propagation edges	fixed by payments: 16 up, 3 down; by convention: 10 up, 2 down
Propagation edges between positions of one holder	7
Loops closed by a payment back	6
Census of the filings	88 annual filings; 269 counterparties named, 125 in a mapped position; 18 propagation edges named

Layer	Position	Holder	Home	Kind	Rating	Substitution
Fabrication and equipment	Rare-earth processing	China	China	control point	B	not measured
Fabrication and equipment	EUV lithography and its optics	ASML, with Carl Zeiss SMT	EU	control point	C	finding [C]
Fabrication and equipment	Deposition, etch and inspection	Applied Materials, Lam Research, KLA (and Tokyo Electron)	United States	control point	B	not measured
Fabrication and equipment	Leading-edge fabrication	TSMC	Taiwan	control point	B	not measured
Chip design	Accelerators and CUDA	Nvidia	United States	control point	A	finding [A]
Chip design	Design software	Synopsys, Cadence	United States	control point	A	not measured
Chip design	Arm instruction set	Arm (Soft-Bank majority)	United Kingdom	control point	B	not measured
Chip design	High-bandwidth memory	SK Hynix, Samsung, Micron	South Korea	control point	B	not measured
Chip design	Storage adapters and	Broadcom	United States	control point	A	concern [A]

Layer	Position	Holder	Home	Kind	Rating	Substitution
	switch silicon					
Chip design	x86 processors	Intel, AMD	United States	competitive	B	
Network and server equipment	Mobile-network equipment	Ericsson, Nokia	EU	control point	A	concern [A]
Network and server equipment	Mobile standard-essential patents	Nokia Technologies (and Ericsson)	EU	control point	B	finding [B]
Network and server equipment	Data-centre switching	Arista, Cisco, Nvidia	United States	competitive	C	
Network and server equipment	Servers	Dell, HPE, contract makers	United States	competitive	C	
Connectivity	Access networks	European operators	EU	competitive	B	
Connectivity	Public internet exchanges	DE-CIX, AMS-IX, NL-ix	EU	run publicly or by a non-profit	O	
Connectivity	International capacity on subsea routes	content and cloud networks	United States	control point	C	not measured
Connectivity	Content delivery and the edge	Cloudflare, Akamai, the hyperscalers	United States	control point	O	not measured
Operating systems and stores	Mobile systems and their stores	Apple, Google	United States	control point	A	finding [A]
Operating systems and stores	PC operating system	Microsoft	United States	control point	A	designation [A]
Infrastructure software	Virtualisation installed base	Broadcom (VMware)	United States	control point	A	finding [A]
Infrastructure software	Database licences and support	Oracle	United States	control point	B	not measured
Infrastructure software	Server operating system on the cloud	Microsoft	United States	control point	A	finding [A]
Cloud infrastructure	Proprietary cloud services, data gravity, ecosystem	AWS, Microsoft, Google	United States	control point	A	finding [A]
Business applications	ERP installed base and its maintenance	SAP	EU	control point	A	concern [A]

Layer	Position	Holder	Home	Kind	Rating	Substitution
Business applications	CRM platform	Salesforce	United States	competitive	C	
Productivity software	The suite bundle, its identity directory and formats	Microsoft	United States	control point	A	concern [A]
Productivity software	Mail operated by public bodies	ministries, universities, research networks	EU	run publicly or by a non-profit	O	
Security	Email filtering	Proofpoint (with Hornetsecurity and Vade), Mimecast, Cisco	United States	control point	O	not measured
Security	Firewalls, identity, monitoring	Palo Alto Networks, Fortinet, CrowdStrike, Zscaler (United States), Check Point (Israel)	United States	competitive	C	
Attention and advertising (apart)	Search and its defaults	Google	United States	control point	A	finding [A]
Attention and advertising (apart)	Advertising-technology chain	Google	United States	control point	A	not measured
Attention and advertising (apart)	Social networks and combined personal data	Meta	United States	control point	A	designation [A]
Attention and advertising (apart)	Music streaming	Spotify	EU	competitive	B	
AI models	Closed frontier models	OpenAI, Anthropic, Google	United States	control point	B	not measured
AI models	European model developers	Mistral AI; Silo AI (AMD's since 2024)	EU	competitive	B	
Distribution and intermediation	Card payment schemes	Visa, Mastercard	United States	control point	A	finding [A]
Distribution and intermediation	Integration and prescription	Accenture, Capgemini, Atos, Sopra	mixed	competitive	A	

Layer	Position	Holder	Home	Kind	Rating	Substitution
Distribution and intermediation	Account-to-account payments	Steria, Orange European banks' schemes; Visa's Tink; Mastercard's former Nets business	mixed	competitive	A	

The evidence for each coding follows. “DNS” marks the paper’s own measurements; the filings are listed under Company filings in the references. For a control point, a second sentence gives the rated finding on substitution, or “not measured” where the coding rests on concentration and an authority’s finding alone. The table grades the finding: a finding proper, a designation of an entrenched position, or a concern, which a commitments decision or a policy restriction states.

- **Rare-earth processing** (B): China’s 2025 export rules extended to products made abroad (ASML 20-F 2025). Substitution: not measured.
- **EUV lithography and its optics** (C): sole EUV supplier (Tom’s [Hardware 2026](#)); Zeiss SMT sole optics supplier under an exclusive arrangement (ASML 20-F 2025). Substitution: no substitute: sole EUV supplier (Tom’s [Hardware 2026](#)) [C].
- **Deposition, etch and inspection** (B): Lam names Applied Materials, Hitachi and Tokyo Electron as its primary etch competitors and Applied Materials in deposition (10-K 2025); the ECA names ASML, Applied Materials and Tokyo Electron as the equipment suppliers (SR 12/2025). Substitution: not measured.
- **Leading-edge fabrication** (B): the ECA names TSMC and Samsung as the front-end leaders, Taiwan and South Korea making the most advanced chips (SR 12/2025); 74.4 percent of TSMC’s revenue from US-headquartered customers (20-F 2025). Substitution: not measured.
- **Accelerators and CUDA** (A): CUDA ‘the only one that is 100% compatible’ (Autorite 24-A-05); data-centre revenue 89.7 percent of Nvidia’s (10-K). Substitution: CUDA ‘the only one that is 100% compatible’ with the GPUs that have become essential (Autorité 24-A-05) [A].
- **Design software** (A): high concentration in the EDA market the Commission examined; Synopsys a leading provider of chip-design IP (IP/25/181). Substitution: not measured.
- **Arm instruction set** (B): royalties 53.1 percent of Arm’s revenue (annual report). Substitution: not measured.
- **High-bandwidth memory** (B): Micron names Samsung and SK hynix first among its competitors (10-K 2025). Substitution: not measured.
- **Storage adapters and switch silicon** (A): dominant or very strong in Fibre Channel host-bus adapters, Marvell the only rival (IP/23/3777); Arista’s predominant switch-silicon vendor (Arista 10-K). Substitution: Marvell the only rival; the Commission’s commitments protect its adapters’ interoperability with VMware (IP/23/3777) [A].
- **x86 processors** (B): two suppliers; Intel’s operating loss in 2025 and AMD’s 10.7 percent operating margin (10-K filings); the sheet records the control point moving from the processor to the accelerator.
- **Mobile-network equipment** (A): Commission, 5G toolbox communication (15 June 2023). Substitution: the alternative suppliers are restricted as high-risk (5G toolbox communication, 2023) [A].

- **Mobile standard-essential patents** (B): standard-essential patents, which the makers of 4G and 5G devices license (Nokia 20-F 2025). Substitution: standard-essential: every 4G and 5G device must license them (Nokia 20-F 2025) [B].
- **Data-centre switching** (C): data-centre Ethernet switching: Arista 19 and Nvidia 15.2 percent in 4Q25 (IDC, March 2026); the switch silicon is Broadcom's (Arista 10-K).
- **Servers** (C): original design manufacturers selling direct 53.2 percent of server revenue in 4Q25, Dell 10.0, Supermicro 9.5, HPE 3.1 (IDC, March 2026).
- **Access networks** (B): several networks in each country, with regulated wholesale access (operators' 20-F filings).
- **Public internet exchanges** (O): 31.6 percent of world exchange port capacity in the EU27 (PeeringDB).
- **International capacity on subsea routes** (C): three-quarters of international bandwidth demand in 2024, stakes in more than 60 cables (TeleGeography). Substitution: not measured.
- **Content delivery and the edge** (O): US edge networks serve 39.0 percent of EU listed companies' websites, 18.3 of ministries' and 9.4 of universities'; Cloudflare alone 23.9 percent of listed companies' (DNS, edge_hosting.py). Substitution: not measured.
- **Mobile systems and their stores** (A): DMA gatekeeper designations (IP/23/4328); anti-steering fine (IP/25/1085). Substitution: users rarely switch: 5 percent had switched from iOS to Android and 8 percent from Android to iOS; those who considered it cited the hassle, learning costs and moving data and apps (CMA mobile ecosystems market study, 2022) [A]; the DMA designation finds an entrenched and durable position (Article 3; IP/23/4328) [A].
- **PC operating system** (A): Bundeskartellamt B6-26/23: Windows 'the historical starting point'. Substitution: the Bundeskartellamt's designation under section 19a, Windows 'the historical starting point' of Microsoft's position (B6-26/23) [A].
- **Virtualisation installed base** (A): District Court of The Hague: the agency was 'klem' (ECLI:NL:RBDHA:2025:11349). Substitution: the court found the agency 'klem' (stuck), unable to negotiate freely (ECLI:NL:RBDHA:2025:11349) [A].
- **Database licences and support** (B): support revenue on licences already sold (10-K). Substitution: not measured.
- **Server operating system on the cloud** (A): 30 to 40 percent of OS usage on Azure in the UK (CMA 2026). Substitution: licensing makes Microsoft's software dearer to run on rival clouds (CMA 2025) [A].
- **Proprietary cloud services, data gravity, ecosystem** (A): CMA final decision (2025); Autorite 23-A-08; three independent market-share sources. Substitution: exit friction measured service by service, 0.90 for DynamoDB (Fermigier 2026a); egress revenue up sixfold while cloud revenue tripled (Autorité 23-A-08, §§448 to 450) [A].
- **ERP installed base and its maintenance** (A): Commission, SAP commitments (IP/26/1554). Substitution: the Commission's commitments on maintenance for the installed base (IP/26/1554) [A]; SAP's migration path for 'installed base customers' (20-F 2025) [B].
- **CRM platform** (C): Salesforce the leader with 21.7 percent of the CRM market in 2023 (IDC, as cited by Salesforce).
- **The suite bundle, its identity directory and formats** (A): Commission, Teams commitments (IP/25/2048); Bundeskartellamt. Substitution: the Commission's commitments on interoperability and data portability for Teams' rivals (IP/25/2048) [A].
- **Mail operated by public bodies** (O): 84.5 percent of ministries' mail domains outside Microsoft and Google (DNS).
- **Email filtering** (O): 55.1 percent of listed companies' gateway-fronted domains under Proofpoint (DNS). Substitution: not measured.

- **Firewalls, identity, monitoring** (C): many vendors from one jurisdiction: the European Parliament’s study finds US and Israeli vendors dominant in firewalls, identity and SIEM (PE 778.576), with no single holder.
- **Search and its defaults** (A): US v. Google (2024); DMA self-preferencing fine (IP/26/1670). Substitution: the court’s findings on the power of defaults (US v. Google 2024) [A].
- **Advertising-technology chain** (A): Commission adtech decision, EUR 2.95bn (IP/25/1992). Substitution: not measured.
- **Social networks and combined personal data** (A): DMA consent-or-pay fine (IP/25/1085). Substitution: the DMA designation of Meta’s social networks finds an entrenched and durable position (Article 3; IP/23/4328) [A].
- **Music streaming** (B): one of the music-streaming providers whose apps Apple’s store terms restricted (IP/24/1161).
- **Closed frontier models** (B): equity ties to the cloud holders (10-K filings); no rated layer share. Substitution: not measured.
- **European model developers** (B): ASML 11.1 percent of Mistral AI, lead investor (20-F 2025); Silo AI, an AI lab based in Finland, acquired by AMD in August 2024 (AMD 10-K).
- **Card payment schemes** (A): ECB 2025: 61 percent of euro-area card payments; PSR CP25/1. Substitution: scheme and processing fees rising without competitive constraint on the acquiring side (PSR CP25/1) [A].
- **Integration and prescription** (A): Autorite 23-A-08: half of migrating customers used an integrator.
- **Account-to-account payments** (A): Mastercard the leading player in A2A core infrastructure; a licence remedy created a rival (IP/20/1487).

Table B2. The acquisitions among the propagation edges. The 14 edges of section 5.4 coded as acquisitions, with the direction each takes by the order of the layers and the evidence behind it. Source: `verify/paper_tables.py`.

Buyer’s position → position bought	Direction	Evidence
Storage adapters and switch silicon → Virtualisation installed base	up	Broadcom, a hardware company, acquired VMware, cleared on commitments that VMware’s software keeps working with the rival adapters (IP/23/3777) [A]
Card payment schemes → Account-to-account payments	same level	Mastercard acquired Nets’ account-to-account business, cleared on a licence remedy (IP/20/1487); Visa acquired Tink for USD 1.9bn (10-K 2022) [A]
The suite bundle, its identity directory and formats → Social networks and combined personal data	up	Microsoft acquired LinkedIn, cleared on commitments (M.8124, IP/16/4284); LinkedIn is reported inside the Productivity and Business Processes segment (10-K) [A]
CRM platform → The suite bundle, its identity directory and formats	same level	Salesforce acquired Slack, now a reported revenue line beside its platform (10-K fiscal 2026) [B]
x86 processors → European model developers	up	AMD acquired Silo AI, an AI lab based in Finland, for USD 665 million in August 2024 (AMD 10-K) [B]
x86 processors → Servers	up	AMD acquired ZT Systems in March 2025, kept its design business and sold its manufacturing to Sanmina (AMD 10-K 2025) [B]

Buyer's position → position bought	Direction	Evidence
Servers → Data-centre switching	same level	HPE merged with Juniper Networks in 2025 (HPE 10-K 2025); Dell acquired Force10 Networks (Arista 10-K) [B]
Data-centre switching → Firewalls, identity, monitoring	up	Cisco acquired Splunk, 'a recognized leader in security analytics and observability', for USD 27.1 billion (Cisco 10-K); Arista acquired Awake Security and Untangle (Arista 10-K) [B]
Servers → Firewalls, identity, monitoring	up	HPE acquired Axis Security, a security service edge provider, in March 2023 (HPE 10-K) [B]
Content delivery and the edge → Firewalls, identity, monitoring	up	Cloudflare acquired Kivera, which 'has developed cloud security, data protection, and compliance technology', in October 2024 (Cloudflare 10-K) [B]
Card payment schemes → Firewalls, identity, monitoring	down	Mastercard acquired Recorded Future, 'a global threat intelligence company', for USD 2.7 billion in December 2024 (Mastercard 10-K) [B]
Firewalls, identity, monitoring → Email filtering	same level	Check Point 'extended Harmony with cloud-email security with the acquisition of Avanan' (20-F) [B]
CRM platform → Integration and prescription	up	Salesforce acquired Traction on Demand, 'a professional services firm that provides ... solutions to clients using the Company's service offerings', in April 2022 (10-K) [B]
Access networks → Integration and prescription	up	Telefónica acquired BE-terna (2022) and IPNET (2024); Vodafone acquired Skaylink, 'a European cloud and digital transformation specialist', in December 2025 (20-F filings) [B]

APPENDIX C. ROBUSTNESS OF THE RENT RATES

The table gives the cents of rent in each euro buyers pay under the six tests of section 4.3. The sector costs of capital are Damodaran's (2026) after-tax figures for January 2026, for US industries in dollars and European industries in euros, converted to pre-tax at a 25 percent tax rate. The card schemes, financed almost wholly by equity, take their sector's cost of equity, since the sector's average firm is a leveraged lender. Research is capitalised by perpetual inventory in steady state: spending R growing at g and depreciating at δ gives a stock $R(1 + g)/(g + \delta)$, added to the capital, and operating income rises by $Rg/(g + \delta)$, the spending not yet depreciated. The growth g is the average over the last two fiscal years. Li and Hall (2020) find depreciation rates for business research generally above 15 percent, the lower of the two rates used. With no growth, the stock is largest and no income is added, which makes it the most adverse case. Organisational capital is capitalised the same way from 30 percent of selling, general and administrative expense, depreciating at 20 percent a year (Peters and Taylor 2017); the holders that file no such line (the card schemes, SAP, TSMC and the operators) are marked. The last column averages the five fiscal years with an income and a balance sheet in the latest annual filing and the three before it. A segment row has the three years of its latest filing and Arm, listed in 2023, has four; the number of years is marked where it is below five. A segment's margin rises in the proportion of its group's income. TSMC, Arm and Check Point take the nearest US sector's cost of capital, since Damodaran's sets cover the United States and Europe. Source: `verify/counterfactual_layers.py`.

Holder	Table 1, at 14%	Good- will kept in the cap- ital	At the sector's cost of capital (pre-tax cost)	Re- search capiti- sated, depreci- ating at 15%; 30%	Most ad- verse: no growth, 15%	Organi- sational capital, 30% of SG&A at 20%	Previ- ous fis- cal year, at 14%	Average over five fis- cal years (fewer where marked)
Nvidia	48.3	47	48.3 (14.1%)	51.9; 51.2	40.3	48.5	51 (2025-01)	31.2
Master- card	38.6	34.5	42.6 (11.0%)	no re- search line	no re- search line	no SG&A line	36 (2024-12)	35.5
Visa	32.1	25.1	38 (11.0%)	no re- search line	no re- search line	no SG&A line	36.2 (2024-09)	32
Mi- crosoft, Produc- tivity and Business Processes	25.4	18.9	29.2 (12.5%)	22.3; 23.5	12.6	23.6	26.4 (2025-06)	26.5 (3)
KLA	25	23.2	26 (13.2%)	22.3; 23.4	14.5	24.4	22.9 (2025-06)	21.9
Broad- com, group	23.8	2.4	23.8 (14.1%)	30.9; 29.4	7.8	24.8	7.7 (2024-11)	22
Lam Re- search	22.1	21.1	22.9 (13.2%)	20.6; 21.1	12.6	22.1	17 (2025-06)	17.2
TSMC	21.7	21.7	21.5 (14.1%)	21.7; 21.7	15.6	no SG&A line	13.3 (2024-12)	13.7
Apple, group	19.9	19.9	20.8 (12.9%)	17.1; 18.2	12.1	19.2	18.4 (2024-09)	17.9
ASML (EU)	14.9	12.9	12.9 (15.4%)	10.9; 12.4	1.5	14.5	10.1 (2024-12)	13.3
Applied Materi- als	13.1	11.3	14.1 (13.2%)	8.8; 10.5	1.4	12.3	13.1 (2024-10)	15
Mi- crosoft, More Personal Com- puting	11.3	8.4	13 (12.5%)	9.9; 10.4	5.6	10.5	11.8 (2025-06)	11.6 (3)
SAP (EU)	10.4	0	14.7 (10.2%)	0; 3.8	0	no SG&A line	0 (2024-12)	3.2
Cadence	8.6	1.3	10.8 (12.5%)	not archived	not archived	7.3	9.2 (2024-12)	11.9
Ericsson (EU)	2.6	0	8 (8.5%)	0; 0	0	0	0 (2024-12)	0.5
Micron	0	0	0 (14.1%)	0; 0	0	0	0 (2024-08)	0.4

Holder	Table 1, at 14%	Good- will kept in the cap- ital	At the sector's cost of capital (pre-tax cost)	Re- search capi- talised, depre- ciating at 15%; 30%	Most ad- verse: no growth, 15%	Organi- sational capital, 30% of SG&A at 20%	Previ- ous fis- cal year, at 14%	Average over five fis- cal years (fewer where marked)
Arm	0	0	0 (14.1%)	0; 0	0	0	0 (2025-03)	0 (4)
Synop- sys	0	0	0 (12.5%)	0; 0	0	0	0.1 (2024-10)	2.3
Cloud- flare	0	0	0 (14.2%)	0; 0	0	0	0 (2024-12)	0
Nokia, Mobile Net- works (EU)	0	0	0 (8.5%)	0; 0	0	0	0 (2024-12)	0 (3)
Oracle, floor un- informa- tive	0	0	0 (12.5%)	0; 0	0	0	4.9 (2025-05)	4.6
Nokia Tech- nologies (EU), floor un- informa- tive	0	0	0 (8.5%)	0; 0	0	0	0 (2024-12)	0 (3)
Arista, no con- trol point	13.2	12.6	21.1 (10.3%)	14.6; 14.2	0.4	13.1	14.5 (2024-12)	12.4
Fortinet, no con- trol point	9.8	9.3	12.1 (12.5%)	9.5; 9.6	0	6.9	7.9 (2024-12)	5
Cisco, no con- trol point	8.8	0	12.9 (10.3%)	5.1; 6.5	0	5.9	5.2 (2025-07)	8.5
Accen- ture, no control point	6.1	1.5	8.3 (10.4%)	5; 5.5	5	3.5	7.3 (2024-08)	6.6
Sales- force, no control point	1.7	0	3.8 (12.5%)	0; 0	0	0	0 (2025-01)	0.3
Check Point, no con- trol point	0.2	0	3.5 (12.5%)	0; 0	0	0	12 (2024-12)	9.6

Holder	Table 1, at 14%	Good- will kept in the cap- ital	At the sector's cost of capital (pre-tax cost)	Re- search capi- talised, depre- ciating at 15%; 30%	Most ad- verse: no growth, 15%	Organi- sational capital, 30% of SG&A at 20%	Previ- ous fis- cal year, at 14%	Average over five fis- cal years (fewer where marked)
Tele- fónica, no con- trol point	0	0	0 (6.5%)	no re- search line	no re- search line	no SG&A line	0 (2023-12)	0.3
Voda- fone, no control point	0	0	0 (6.5%)	no re- search line	no re- search line	no SG&A line	0 (2025-03)	0
Dell, no control point	0	0	0 (12.9%)	0; 0	0	0	0 (2025-01)	0
HPE, no control point	0	0	0 (12.9%)	0; 0	0	0	0 (2024-10)	0
Palo Alto Net- works, no con- trol point	0	0	0 (12.5%)	0; 0	0	0	0 (2025-07)	0
Crowd- Strike, no con- trol point	0	0	0 (12.5%)	0; 0	0	0	0 (2025-01)	0
Zscaler, no con- trol point	0	0	0 (12.5%)	0; 0	0	0	0 (2025-07)	0
Intel, no control point	0	0	0 (14.1%)	0; 0	0	0	0 (2024-12)	0
AMD, no con- trol point	0	0	0 (14.1%)	0; 0	0	0	0 (2024-12)	2.4
<i>Google Services, charged with Al- phabet- level costs, apart</i>	14	12.7	13.6 (14.2%)	13.8; 13.9	0	12.6	not com- puted	not com- puted
<i>Meta, Family</i>	22	19.8	21.5 (14.2%)	26.8; 25.4	0	19.1	26 (2024-12)	21.9 (3)

Holder	Table 1, at 14%	Good- will kept in the cap- ital	At the sector's cost of capital (pre-tax cost)	Re- search capi- talised, depre- ciating at 15%; 30%	Most ad- verse: no growth, 15%	Organi- sational capital, 30% of SG&A at 20%	Previ- ous fis- cal year, at 14%	Average over five fis- cal years (fewer where marked)
<i>of Apps, apart</i>								
<i>Spotify, apart</i>	1.4	0.6	1.3 (14.2%)	0; 0	0	no SG&A line	0 (2024-12)	0.3

Alphabet's group-level costs are taken from its latest filing only, so Google Services has no previous-year rate. Cadence's research spending is not in the archive. The cloud rows of Table 1 rest on the CMA's return floors and are not tested here.

DISCLOSURE

The author sits on the supply side: he is co-president of CNLL, which represents French open-source companies, and a co-founder and board member of the EuroStack Foundation. His company, Abilian, is a software vendor.

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