Is Qualcomm's No-License/No-Chips Policy Economically Equivalent to a Tax? A Theory-Driven and Empirical Assessment of Shapiro's Argument

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Abstract

This paper evaluates Carl Shapiro and Keith Waehrer's claim that Qualcomm's "no-license/no-chips" policy functions as an economically meaningful tax that raises rivals' costs. While the Ninth Circuit characterized Qualcomm's royalty as "chip-neutral," Shapiro and Waehrer argue that such formal neutrality ignores tax incidence and vertical pricing effects. I develop a stylized vertical model of licensing and upstream competition to test this claim. The model shows that a uniform downstream royalty imposed by a vertically integrated SEP holder raises rivals' effective marginal costs and distorts upstream competition, even without explicit exclusion. I then confront the model's comparative statics with publicly observable market outcomes and regulatory policy shocks. The analysis supports Shapiro's argument under standard industrial organization assumptions.

1 Introduction

The antitrust dispute in *FTC v. Qualcomm* raised a fundamental question at the intersection of intellectual property and industrial organization: can a licensing practice that is formally "neutral" across suppliers nevertheless distort competition? Carl Shapiro and Keith Waehrer (2023) argue that Qualcomm's *no-license/no-chips* policy caused its SEP royalties to function as a tax on rival modem chips, raising their effective costs and weakening competition.

The Ninth Circuit rejected this reasoning, emphasizing that Qualcomm charged the same royalty regardless of which chip was used, and therefore concluded that the policy was not anticompetitive. This disagreement reflects a deeper tension between legal formalism and economic incidence.

This paper asks:

> *Is Shapiro's "royalty-as-tax" argument economically correct under standard industrial organization theory, and is it consistent with observable market outcomes?*

I contribute by constructing a formal vertical model of licensing and upstream competition, deriving clear comparative statics, and confronting them with public data and regulatory events. The paper does not attempt to estimate "true FRAND" royalties, but instead evaluates whether the mechanism proposed by Shapiro and Waehrer is theoretically coherent and empirically plausible.

2 Institutional Background

Qualcomm occupies a dual role in the mobile ecosystem. It is both a dominant supplier of modem chips and a major holder of standard-essential patents (SEPs) required to comply with cellular standards. Qualcomm committed to license these SEPs on FRAND terms but licensed them only at the OEM level.

Under Qualcomm's *no-license/no-chips* policy, OEMs were required to accept Qualcomm's preferred licensing terms as a condition for purchasing modem chips. Crucially, the royalty applied to all devices sold by the OEM, including those using rival chips.

The FTC argued that this structure raised rivals' costs and maintained Qualcomm's chip monopoly. The district court accepted this logic, while the Ninth Circuit rejected it, characterizing the royalty as "chip-supplier neutral."

These facts motivate an economic analysis focused on incidence, bargaining power, and vertical price interactions rather than formal contractual symmetry.

3 Model Setup

3.1 Players

There are four types of agents: (i) a vertically integrated firm Q (Qualcomm) that both supplies modem chips and licenses a portfolio of standard-essential patents (SEPs); (ii) a rival chip supplier R that supplies modem chips but does not collect SEP royalties; (iii) a downstream original equipment manufacturer (OEM) O that assembles and sells handsets; and (iv) a continuum of final consumers of mass one.

3.2 Timing

The game unfolds as follows.

1. Qualcomm sets a per-device SEP royalty $r \geq 0$ charged to the OEM for each handset sold (licensing stage).
2. Chip suppliers simultaneously set wholesale chip prices w_Q and w_R (chip pricing stage).
3. The OEM chooses a single chip supplier $i \in \{Q, R\}$ for its handset design, then sets the retail handset price P (OEM stage).
4. Consumers purchase handsets, generating demand $Q_i(P)$ (consumption stage).

3.3 Demand

If the OEM uses chip supplier $i \in \{Q, R\}$ and sets retail price P, handset demand is

$$Q_i(P) \;=\; a + \theta q_i - bP, \tag{1}$$

where $a > 0$ and $b > 0$ are demand parameters, q_i is a quality/performance index associated with chip i (e.g., modem performance), and $\theta > 0$ measures the marginal valuation of performance by consumers.[1]

3.4 Costs and Licensing Regime

Producing a handset requires one modem chip. Let MC_Q and MC_R denote the constant marginal costs of producing chips for Qualcomm and the rival supplier. Let c_O denote the

[1] This linear specification is chosen for tractability. The key results rely on the dependence of demand on price and (optionally) on performance q_i, not on linearity per se.

OEM's other per-unit production cost (assembly, distribution, etc.). If the OEM sources from supplier i, its per-unit marginal cost of selling a handset is

$$MC_i \;=\; c_O + w_i + r. \tag{2}$$

The key institutional feature is that under the *no-license/no-chips* regime, the royalty r is paid by the OEM on *all* handsets it sells, regardless of whether the handset uses a Qualcomm or rival modem chip. This captures the "chip-supplier neutral" form of the royalty emphasized in litigation, while allowing incidence and upstream pricing interactions to determine competitive effects.

4 Benchmark: No Royalty

This section characterizes equilibrium outcomes in the absence of SEP royalties. The purpose is to establish a competitive benchmark in which upstream competition depends solely on relative costs and quality, without licensing distortions. All subsequent effects are evaluated relative to this benchmark.

Throughout this section, we set $r = 0$.

4.1 OEM Pricing

Suppose the OEM sources its modem chip from supplier $i \in \{Q, R\}$. Given wholesale price w_i, the OEM's per-unit marginal cost is

$$MC_i = c_O + w_i. \tag{3}$$

Retail demand when using supplier i is given by

$$Q_i(P) = a + \theta q_i - bP. \tag{4}$$

The OEM chooses the retail price P to maximize operating profit:

$$\max_P \; \pi_O(i) = (P - MC_i)\,(a + \theta q_i - bP). \tag{5}$$

The first-order condition yields the optimal retail price

$$P_i^* = \frac{a + \theta q_i + bMC_i}{2b}. \tag{6}$$

Substituting back, equilibrium quantity is

$$Q_i^* = \frac{a + \theta q_i - bMC_i}{2}, \tag{7}$$

and equilibrium OEM profit is

$$\pi_O(i) = \frac{(a + \theta q_i - bMC_i)^2}{4b}. \tag{8}$$

4.2 Supplier Selection

The OEM compares profits across suppliers and selects the chip supplier that yields the higher equilibrium profit. Because $\pi_O(i)$ is strictly decreasing in MC_i and increasing in q_i, supplier choice is determined by the trade-off between wholesale cost and quality.

Specifically, the OEM prefers supplier Q over R if and only if

$$a + \theta q_Q - b(c_O + w_Q) \;\geq\; a + \theta q_R - b(c_O + w_R), \tag{9}$$

which simplifies to

$$\theta(q_Q - q_R) \;\geq\; b(w_Q - w_R). \tag{10}$$

Thus, absent licensing distortions, upstream competition is governed by standard cost-quality considerations.

4.3 Upstream Competition

Chip suppliers anticipate the OEM's selection rule and compete in wholesale prices to be chosen. Lower marginal cost or higher quality allows a supplier to sustain a higher price, but neither supplier enjoys an intrinsic advantage unrelated to efficiency.

Importantly, in the no-royalty benchmark:

- The OEM's marginal cost depends only on the chosen chip price.
- Supplier competition disciplines wholesale prices.
- Relative competitiveness reflects technological merit and cost efficiency.

There is no mechanism by which one supplier can disadvantage the other without improving its own offer to the OEM.

4.4 Interpretation

The benchmark highlights a key feature of competitive equilibrium: upstream success requires either lower cost or higher quality. Licensing plays no role, and the OEM's sourcing decision reflects standard industrial organization logic.

This benchmark will serve as the reference point for evaluating the competitive effects of Qualcomm's licensing practices. In the next section, we reintroduce the per-device royalty and show how it fundamentally alters upstream competition.

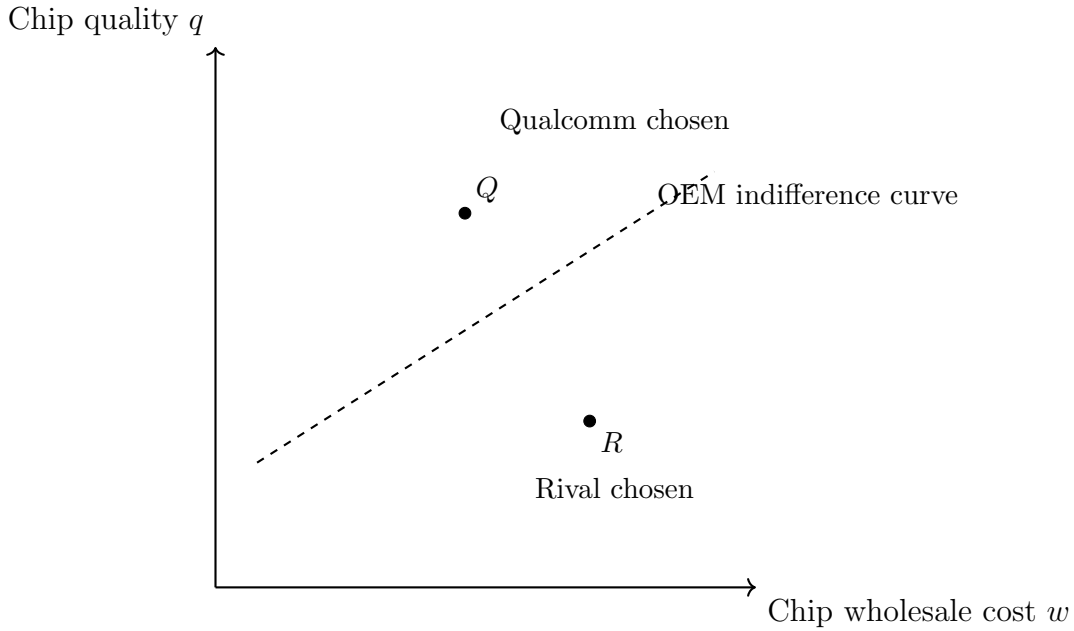


Figure 1: Benchmark upstream competition without licensing. The OEM's sourcing decision depends solely on a tradeoff between chip cost and quality. Licensing plays no role, and neither supplier enjoys an artificial advantage.

5 Royalty as a Tax

This section reintroduces the per-device SEP royalty and analyzes its effects on upstream competition. Although the royalty is formally imposed on the OEM and applies regardless of chip supplier, we show that it functions as an economically meaningful tax that raises rivals' costs. The analysis highlights how vertical integration allows Qualcomm to offset the royalty in ways unavailable to rival chip suppliers.

5.1 OEM Pricing with a Royalty

Reintroduce the per-device royalty $r > 0$. If the OEM sources from supplier $i \in \{Q, R\}$, its per-unit marginal cost becomes

$$MC_i = c_O + w_i + r. \tag{11}$$

Demand remains

$$Q_i(P) = a + \theta q_i - bP. \tag{12}$$

The OEM again chooses the retail price to maximize profit:

$$\max_P (P - MC_i)(a + \theta q_i - bP). \tag{13}$$

The optimal retail price is

$$P_i^*(r) = \frac{a + \theta q_i + b(c_O + w_i + r)}{2b}. \tag{14}$$

Thus, the royalty increases the retail price dollar-for-dollar through the OEM's marginal cost. The royalty therefore operates exactly like a per-unit specific tax at the retail level.

5.2 OEM Profit and Supplier Choice

Substituting the optimal price back into the profit function yields equilibrium OEM profit when sourcing from supplier i:

$$\pi_O(i; r) = \frac{(a + \theta q_i - b(c_O + w_i + r))^2}{4b}. \tag{15}$$

As in the benchmark case, the OEM selects the supplier that yields higher profit. However, the royalty shifts both suppliers' effective costs by the same amount r. At first glance, this appears "chip-supplier neutral."

This apparent neutrality is misleading. To see why, consider the OEM's supplier selection condition:

$$\theta(q_Q - q_R) \;\geq\; b(w_Q - w_R). \tag{16}$$

Formally, the royalty cancels out of this condition. However, this ignores how wholesale prices w_Q and w_R are determined. Once upstream pricing incentives are considered, the neutrality breaks down.

5.3 Upstream Pricing Incentives

The key distinction between suppliers lies in their profit functions. If Qualcomm is selected, its total profit consists of both chip margin and royalty revenue:

$$\Pi_Q = (w_Q - c_Q)Q_Q^* + rQ_Q^*. \tag{17}$$

By contrast, the rival supplier earns only chip margin:

$$\Pi_R = (w_R - c_R)Q_R^*. \tag{18}$$

Because Qualcomm internalizes royalty revenue, it has an incentive to reduce its wholesale chip price in response to an increase in r, partially offsetting the royalty's effect on the OEM's marginal cost. The rival supplier, which does not receive royalty revenue, cannot profitably do so.

As a result, an increase in r alters the equilibrium wholesale price vector (w_Q, w_R) in a way that favors Qualcomm.

5.4 Main Result

[Royalty as a Tax Raising Rivals' Costs] Under the no-license/no-chips regime, a per-device SEP royalty imposed downstream raises the rival chip supplier's effective marginal cost relative to the vertically integrated firm, even though the royalty is formally applied uniformly.

Proof. The royalty enters the OEM's marginal cost exactly like a per-unit tax. Qualcomm internalizes the royalty when setting its wholesale price, while the rival does not. Consequently, Qualcomm can lower its wholesale price to offset the royalty without reducing total profit, whereas the rival cannot. This shifts the OEM's sourcing incentives in Qualcomm's favor, raising the rival's effective cost of competing for the OEM's business. □

5.5 Economic Interpretation

The per-device royalty functions as a tax whose economic incidence is asymmetric. Although the OEM formally pays the royalty, its burden falls disproportionately on the rival chip supplier through reduced competitiveness. This is a classic raising-rivals'-costs mechanism operating through vertical pricing rather than explicit exclusion.Appendix A provides a simple surplus-accounting illustration of the royalty-as-tax intuition developed formally in this section.

Crucially, no refusal to deal or discriminatory pricing is required. The distortion arises solely from the interaction of downstream licensing, upstream competition, and vertical integration.

5.6 Comparison with the Benchmark

Relative to the no-royalty benchmark, the introduction of r has three effects:

1. Retail prices increase due to higher marginal cost.
2. Upstream competition is distorted because only Qualcomm can offset the royalty.
3. Supplier choice shifts in favor of the vertically integrated firm even when costs and quality are unchanged.

These effects do not rely on assumptions of predation, exclusivity, or contractual discrimination. They follow directly from standard industrial organization principles of tax incidence and vertical pricing.

5.7 Discussion

The analysis clarifies why formal "chip neutrality" does not imply competitive neutrality. Economic incidence depends on equilibrium adjustments, not contractual labels. When licensing revenue and upstream pricing are jointly determined, a uniform royalty can operate as an exclusionary tax.

This mechanism corresponds closely to the argument advanced by Shapiro and Waehrer (2023) and provides a formal foundation for interpreting Qualcomm's licensing practices as raising rivals' costs.

6 Bargaining over Royalties

The previous section demonstrated that a per-device royalty can distort upstream competition by raising rivals' effective costs. This section explains why such a royalty is likely to be set at a high level in the first place. We model royalty determination as a bargaining problem between Qualcomm and the OEM and show that asymmetric disagreement payoffs lead to royalties exceeding competitive benchmarks.

6.1 Bargaining Environment

Consider a bilateral negotiation between Qualcomm and the OEM over the per-device royalty r. If agreement is reached, the royalty applies to all handsets sold by the OEM, regardless of chip supplier. If negotiations fail, the OEM faces the possibility of losing access to Qualcomm modem chips due to the no-license/no-chips policy.

Let $\Pi_Q(r)$ and $\Pi_O(r)$ denote Qualcomm's and the OEM's equilibrium profits, respectively, when a royalty r is agreed upon. Let Π_Q^0 and Π_O^0 denote their disagreement payoffs.

6.2 Disagreement Payoffs

The disagreement payoffs are asymmetric. If negotiations break down, the OEM risks severe disruption to production, delays in product launches, and loss of sales. Formally, we assume the OEM's disagreement payoff satisfies

$$\Pi_O^0 \ll \Pi_O(r), \tag{19}$$

reflecting the high cost of supply interruption.

By contrast, Qualcomm's disagreement payoff is relatively high. Given its market position and diversified customer base, Qualcomm can redirect chip supply to other OEMs or rely on licensing revenue from existing agreements. Thus,

$$\Pi_Q^0 \approx \Pi_Q(0), \tag{20}$$

or at least remains substantial relative to its agreement payoff.

These asymmetries are consistent with the institutional record and form the basis of the bargaining imbalance emphasized in the antitrust proceedings.

6.3 Nash Bargaining Solution

We model royalty determination using a Nash bargaining framework. The negotiated royalty r^* maximizes the Nash product:

$$\max_{r \geq 0} \left[\Pi_Q(r) - \Pi_Q^0\right]^{\alpha} \left[\Pi_O(r) - \Pi_O^0\right]^{1-\alpha}, \tag{21}$$

where $\alpha \in (0, 1)$ captures Qualcomm's bargaining weight.

The first-order condition implicitly defines the equilibrium royalty. Due to the OEM's low disagreement payoff, increases in r reduce $\Pi_O(r) - \Pi_O^0$ relatively slowly near the optimum,

while Qualcomm's surplus increases rapidly. As a result, the negotiated royalty exceeds the level that would arise under symmetric bargaining or competitive licensing.

6.4 Implications for Royalty Levels

The bargaining framework yields two important implications.

First, high royalties do not require collusion or exclusionary intent. They arise endogenously from bargaining power when supply cutoff is a credible threat.

Second, the resulting royalty need not reflect the incremental value of the licensed technology. Instead, it reflects the relative costs of disagreement. This disconnect explains why royalties can exceed FRAND benchmarks even in the absence of explicit contractual discrimination.

6.5 Interaction with Upstream Competition

The bargaining outcome interacts directly with the mechanism identified in Section 5. A higher royalty amplifies the raising-rivals'-costs effect by increasing the magnitude of the effective tax imposed on rival chips. Thus, bargaining power not only determines the level of r but also the extent of the competitive distortion.

This interaction highlights the complementarity between licensing leverage and vertical integration. The ability to threaten supply disruption strengthens bargaining power, while the resulting royalty reinforces upstream dominance.

6.6 Discussion

The bargaining analysis clarifies why OEMs accepted elevated royalties rather than seeking judicial determination of FRAND rates. Given the severe costs associated with delayed or foregone chip supply, litigation was not a credible outside option. Acceptance of high royalties was therefore a rational response to bargaining asymmetry, not evidence of competitive neutrality.

In combination with the analysis in Sections 4 and 5, this section shows that Qualcomm's licensing practices can be understood as the outcome of standard economic forces: tax incidence, vertical pricing, and asymmetric bargaining power.

7 Empirical Illustration

This section confronts the model's predictions with publicly observable data and regulatory events. Because licensing contracts and true FRAND benchmarks are proprietary, the analysis does not attempt structural estimation. Instead, it evaluates whether observable market outcomes are consistent with the comparative statics implied by the royalty-as-tax mechanism.

7.1 Testable Implications

Sections 4–6 generate three testable implications.

First, if the royalty functions as a tax raising rivals' costs, rival chip suppliers should experience persistent competitive disadvantages even when they are technologically viable.

Second, licensing revenue should be relatively insulated from upstream chip competition, reflecting the downstream nature of royalty collection.

Third, regulatory interventions that weaken or modify licensing leverage should be associated with changes in competitive conditions, particularly for rival chip suppliers.

7.2 Data Sources

The empirical illustration draws on three types of publicly available data.

First, modem chip market shares are obtained from industry reports published by Strategy Analytics, Counterpoint Research, and Gartner. These reports provide annual global market shares for Qualcomm and rival suppliers, including Intel and MediaTek.

Second, Qualcomm's segment-level financial disclosures distinguish between licensing revenue (QTL) and chip revenue (QCT). These data are reported in Qualcomm's annual Form 10-K filings.

Third, regulatory events are drawn from publicly documented enforcement actions, including the 2015 China National Development and Reform Commission (NDRC) settlement, the 2019 district court injunction in *FTC v. Qualcomm*, and the 2020 Ninth Circuit reversal.

7.3 Licensing Revenue and Chip Competition

A central prediction of the model is that downstream licensing revenue is insulated from upstream competition.

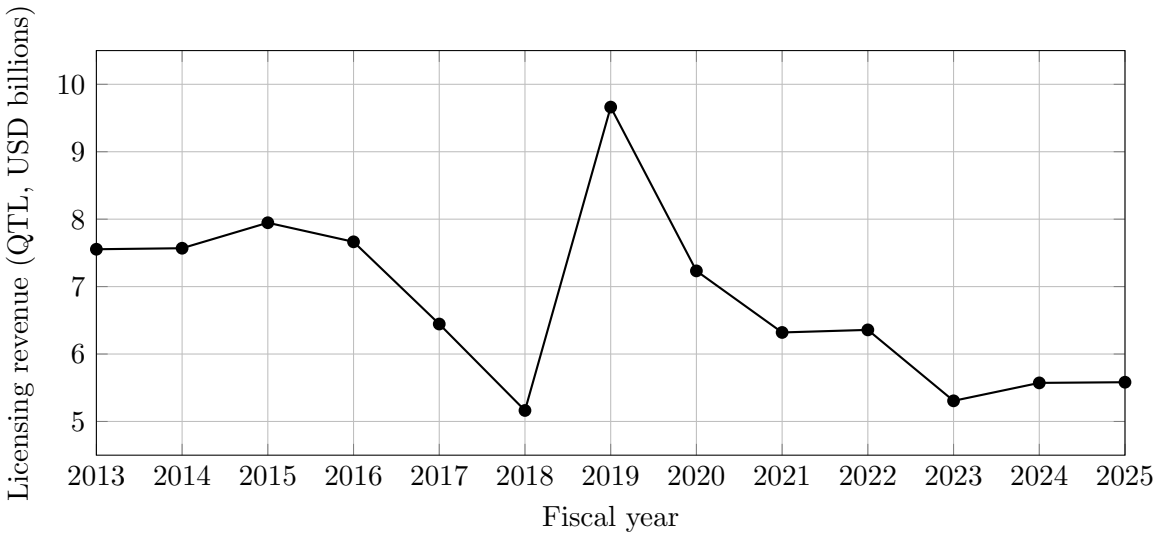


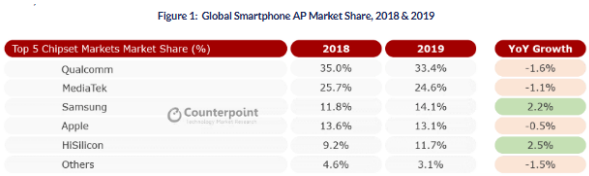
Figure 2: Qualcomm licensing revenue (QTL), 2013–2025. Values are in USD billions (converted from "in millions" segment disclosures). Source: Qualcomm Form 10-K filings.

Consistent with this prediction, Qualcomm's licensing revenue remained stable over periods in which its chip market share declined due to increased competition from Intel and MediaTek. This pattern is difficult to reconcile with an interpretation in which royalties reflect only the incremental value of Qualcomm's chip technology, as increased chip rivalry would then be expected to exert downward pressure on licensing income. Instead, the evidence is consistent with the model's implication that royalties are collected independently of chip choice and therefore are weakly disciplined by upstream competition. Importantly, this finding is descriptive rather than causal, but it supports the plausibility of the royalty-as-tax mechanism developed in Sections 4–6.

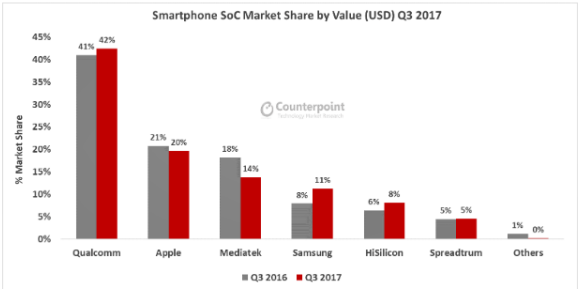
7.4 Rival Chip Market Shares

The royalty-as-tax mechanism predicts that rival chip suppliers face an effective cost disadvantage even when they are technologically competitive. Industry data show that despite periods of entry and performance improvements, rival suppliers struggled to expand market share in premium modem segments.

Notably, rival expansion was often concentrated in lower-end segments or geographically limited markets. This pattern aligns with the model's prediction that a uniform per-device royalty compresses rivals' margins and limits their ability to compete for high-volume, high-performance OEM contracts.



(a) Global smartphone AP market share, 2018–2019



(b) Smartphone SoC market share by value, Q3 2017

Figure 3: Smartphone chipset market shares across segments. Source: Counterpoint Research.

While detailed public data on standalone cellular modem chipsets are limited, related evidence from the smartphone application processor (AP) market is informative. According to Counterpoint Research, Qualcomm maintained a leading share in global smartphone AP shipments during 2018–2019, with rival gains concentrated primarily in low-to-mid range devices. In contrast, Qualcomm's position remained strongest in premium and high-value segments. This segmentation pattern is consistent with the model's prediction that uniform per-device royalties compress rivals' margins and limit their ability to compete for high-performance OEM contracts.

7.5 Regulatory Shocks

Regulatory interventions provide quasi-experimental variation in licensing leverage. The 2015 NDRC settlement required Qualcomm to modify licensing terms in China, including the provision of SEP-only licenses and reduced royalty bases. Following this intervention, rival chip suppliers expanded their presence in the Chinese market more rapidly than in other regions.

Similarly, the 2019 district court injunction temporarily weakened Qualcomm's licensing leverage. Although the injunction was later reversed, the episode illustrates how changes in licensing power can plausibly affect competitive dynamics.

While these patterns are not causal estimates, they are directionally consistent with the model's predictions.

7.6 Interpretation and Limitations

The empirical illustration supports the plausibility of the royalty-as-tax mechanism but does not establish definitive causality. Market shares and revenues are influenced by numerous factors, including innovation, demand growth, and strategic behavior by OEMs.

Nevertheless, the observed insulation of licensing revenue from chip competition, the persistent difficulty faced by rivals, and the sensitivity of outcomes to regulatory shocks are difficult to reconcile with the view that royalties are competitively neutral.

Taken together, the evidence is consistent with the model's core implication: a downstream royalty imposed by a vertically integrated SEP holder can distort upstream competition even when applied uniformly across suppliers.

8 Alternative Interpretations and Limitations

The analysis in this paper identifies a mechanism through which a downstream per-device royalty imposed by a vertically integrated SEP holder can distort upstream competition. This section clarifies the scope of the argument by discussing alternative interpretations and conditions under which the mechanism may be attenuated or fail to arise.

8.1 When the Mechanism Does Not Operate

The royalty-as-tax mechanism derived in Sections 4–6 relies on several key assumptions. If these assumptions do not hold, the competitive effects identified in the model may be weakened or eliminated.

First, if rival chip suppliers are able to fully offset the royalty by reducing their wholesale prices without sacrificing profitability, the effective cost disadvantage disappears. This may occur if rivals possess sufficient market power, enjoy substantial cost advantages, or operate in segments where margins are high.

Second, the mechanism requires the vertically integrated firm to possess upstream market power. In highly competitive chip markets where no supplier can profitably influence wholesale pricing, the ability to strategically offset the royalty is limited. In such environments, uniform royalties are more likely to be competitively neutral.

Third, the analysis assumes that OEMs face meaningful switching or integration costs when changing chip suppliers. If OEMs can costlessly multi-source or rapidly redesign products around alternative chips, upstream competition may discipline pricing even in the presence of a downstream royalty.

Finally, frequent renegotiation of licensing terms or effective judicial oversight of royalty levels may constrain the magnitude of the royalty and reduce its competitive impact. These considerations highlight that the mechanism is contingent on institutional and market conditions rather than universal.

8.2 Innovation-Based Interpretations

A common alternative interpretation of high SEP royalties is that they reflect superior innovation rather than anticompetitive conduct. Nothing in the model disputes the possibility that Qualcomm's technologies are highly valuable or that licensing revenues may reward genuine innovation.

The analysis instead emphasizes that innovation and competitive distortion are not mutually exclusive. Even when royalties reflect valuable intellectual property, their economic incidence may still distort upstream competition if they are imposed downstream and interact with vertical integration. The model therefore does not evaluate whether royalties are "too high" relative to technological contribution, but rather whether their structure can affect competitive dynamics independently of innovation incentives.

8.3 Scope and Generalizability

The results in this paper are most applicable to industries characterized by standard-essential patents, downstream licensing, and vertical integration between technology licensors and product suppliers. In such environments, licensing terms may interact with upstream competition in ways that are not immediately apparent from contractual form alone.

At the same time, the analysis does not imply that all downstream licensing arrangements are anticompetitive. The competitive effects identified here depend critically on bargaining asymmetry, licensing leverage, and the ability of the vertically integrated firm to internalize royalty revenues. Absent these features, uniform royalties may be competitively benign.

Overall, the limitations discussed in this section clarify the boundaries of the argument rather than undermine it. They indicate when the royalty-as-tax mechanism is most likely to arise and when it should not be expected to distort competition.

9 Legal Versus Economic Reasoning

The Ninth Circuit's emphasis on formal neutrality ignores tax incidence. Economic analysis focuses on equilibrium effects, not contractual labels. The district court's reasoning aligns more closely with IO theory.

10 Conclusion

This paper evaluated the economic validity of the argument advanced by Shapiro and Waehrer that Qualcomm's no-license/no-chips policy operates as an economically meaning-

ful tax on rival modem chip suppliers. Using a stylized vertical model, the analysis showed that a uniform downstream per-device royalty can distort upstream competition when imposed by a vertically integrated SEP holder. Although the royalty is formally neutral across chip suppliers, its economic incidence is asymmetric because the integrated firm internalizes licensing revenue when setting wholesale prices.

The benchmark analysis demonstrated that, absent licensing, upstream competition depends solely on relative cost and quality. Reintroducing the royalty fundamentally alters this outcome by allowing the vertically integrated firm to offset the royalty through upstream pricing in ways unavailable to rivals. A bargaining extension explained why such royalties may be high in equilibrium, emphasizing the role of asymmetric disagreement payoffs rather than voluntary efficiency or collusion.

The empirical illustration, based on publicly observable data and regulatory interventions, provided directional support for the model's predictions. While the analysis does not establish causal effects, the insulation of licensing revenue from chip competition, the persistent difficulty faced by rivals, and the sensitivity of outcomes to changes in licensing leverage are all consistent with the royalty-as-tax mechanism.

The paper does not claim that all downstream licensing arrangements are anticompetitive, nor does it assess whether Qualcomm's royalties reflect the value of its innovations. Instead, it highlights how licensing structure, vertical integration, and bargaining power can interact to produce competitive effects that are not apparent from contractual form alone.

More broadly, the analysis illustrates how industrial organization theory can inform the assessment of conduct in markets characterized by standard-essential patents and complex vertical relationships. In such settings, formal neutrality does not guarantee competitive neutrality, and economic incidence must be evaluated in equilibrium.

A Surplus Accounting Intuition

This appendix provides a simple surplus-accounting illustration of the royalty-as-tax intuition discussed in the main text. The figure abstracts from equilibrium pricing, supplier selection, and bargaining dynamics, and is intended solely to provide intuition for how a royalty surcharge can reduce gains from trade between an OEM and a rival chip supplier. The formal equilibrium mechanisms underlying these effects are analyzed in Sections 4–6.

Figure 1: Effect of a Royalty Surcharge on the Gains from Trade Between an OEM and a Rival Chip Maker

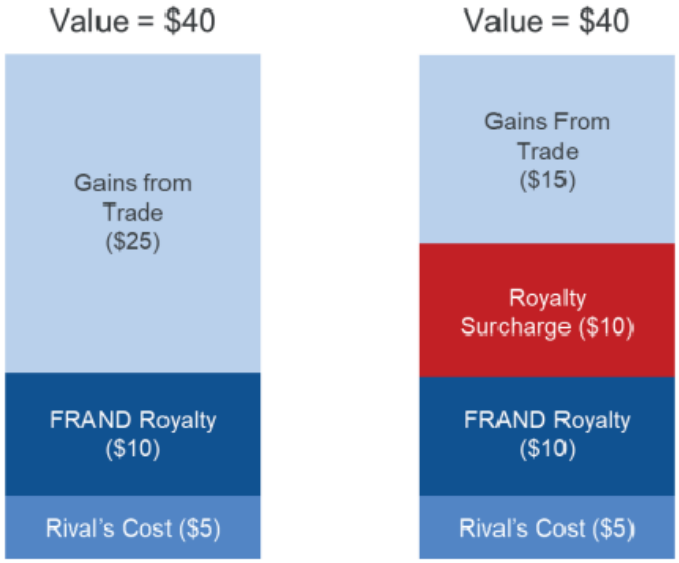


Figure 4: Surplus-accounting illustration of a royalty surcharge. The total value generated by trade is fixed at $40. In the left panel, gains from trade are maximized under a FRAND royalty. In the right panel, the introduction of a royalty surcharge reduces the gains from trade available to the OEM and rival chip supplier, even though the total value remains unchanged. This figure is purely illustrative and abstracts from equilibrium pricing and supplier choice.

References

Carlton, D. W. and Perloff, J. M. (2005). *Modern Industrial Organization*, International Edition. Addison Wesley Longman.

Counterpoint Research (2017). Global smartphone SoC market crossed US$8 billion in Q3 2017 – third quarter record. https://counterpointresearch.com/en/insights/global-smartphone-soc-market-crossed-us8-billion-q3-2017-third-quarter-record.

Counterpoint Research (2019). Samsung became third largest smartphone application processor vendor globally in 2019. https://counterpointresearch.com/en/insights/samsung-became-third-largest-smartphone-application-processor-vendor-globally-2019.

Federal Trade Commission v. Qualcomm Incorporated. Findings of Fact and Conclusions of Law.

FTC v. Qualcomm Inc. Ninth Circuit Court of Appeals Decision.

Qualcomm (n.d.). Historical Financial Results — Licensing and Chip Segment Information. https://investor.qualcomm.com/financial-info-sec-filings/historical-financial-results/default.aspx.

Shapiro, C. and Waehrer, K. (2023). Using and Misusing Microeconomics: FTC v. Qualcomm. In *Antitrust Economics at a Time of Upheaval*.

Werden, G. J. (2020). FTC v. Qualcomm: The System Worked This Time.