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Research Article

Cyber Insurance for DevSecOps Risks: Pricing Models and Coverage Gaps

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ABSTRACT

With organizations large and small quickly moving to DevSecOps processes, the long-established cyber insurance business model is being viciously struggled with underwriting risks brought by CI/CD pipelines and Infrastructure as Code (IaC). The question this paper seeks to answer is, in light of attack surface changes, how insurance providers are re-adjusting pricing mechanisms and filling coverage gaps? Empirical evidence, risk modelling specific to the industry, and a study of the decision-making processes of underwriters allow us to reveal major gaps between the security posture of DevSecOps and the confidence of insurers. In the findings, it is clear that a reevaluation of actuarial models, a creation of uniform security standards, and more precise policy wording are needed to create better alignment between the worlds of technology and financial mitigation of risk via cyber insurance.

Keywords: DevSecOps, Insurance, Cyber, Price

I. INTRODUCTION

DevSecOps has changed the notion of software delivery, focusing on the speed of delivery, automation, and security embedded throughout development lifecycles. Though this transition has increased resilience and responsiveness, it has also created complex dynamic risks that are difficult to be understood by the conventional cyber insurance models. CI/CD, IaC, and deployment pipelines automatically broaden the attack surface area, increasing the difficulty of insurers to estimate risk and charge the correct premium.

This study examines how insurance underwriters are responding to these pressures especially with regard to modeling, pricing and determining coverage. It will seek to close the gap between the changing DevSecOps landscapes and the existing underwriting approaches used by the insurance industry.

II. RELATED WORKS

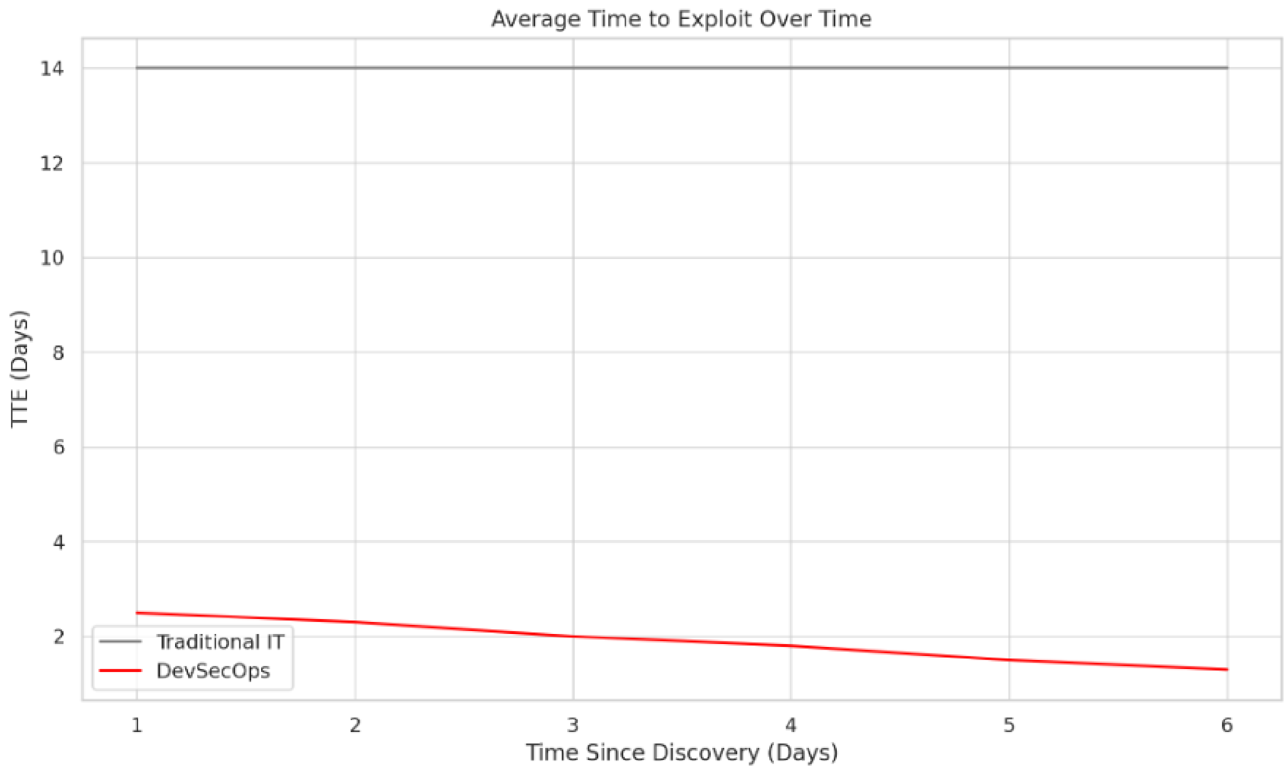
Cyber Insurance Pricing

The major difference between cyber insurance pricing and traditional insurance is linked to operating on incomplete and emerging data landscapes. The structure of premiums in classical insurance models is built via sound loss data of the past stratified by sectors, geography and size of organization.

Nevertheless, these empirical baselines continue to develop in the field of cyber risk, which generates significant pricing model uncertainty [1]. Customary actuarial practices, which have been refined over time to address more conventional risks, cannot be marshaled to take into consideration systemic cyber-incidents, secondary breaches, and third-party vendor vulnerabilities.

In order to address these issues, the recent literature has introduced the concept of multidimensional modeling frameworks that incorporates operational structure, economic models, and cybersecurity maturity indices [1]. The models seek to reflect the interconnected digital systems, especially in cases where a shared dependency or misconfiguration in Infrastructure as Code (IaC) and continuous integration and continuous delivery (CI/CD) pipelines may lead to the local breach being propagated into an industry-wide event [6][8].

Cyber insurance modeling has been developed further on its mathematical basis with risk-neutral valuations, stochastic simulations, and set-valued monetary risk measures used to handle the multidimensionality of cyber threats [2].



This reformulation is particularly relevant in the case of emerging DevSecOps paradigm, where security is inserted into continuous delivery pipelines and cloud provisioning mechanisms. Security as part of DevOps does not only add technical complexity but potentially even a larger threat surface area owing to the scale of automation [7][9]. As a result, underwriters find themselves with the twin difficulties of measuring both stationary risks (e.g., improperly set access policies) and dynamic risks (e.g., automated deployments carrying un-vetted code), against which there may be little or no prior precedent.

CI/CD and IaC

The emergence of Continuous Integration and Continuous Deployment (CI/CD) pipelines and Infrastructure as Code (IaC) has transformed the operational core of contemporary software companies, and created previously unforeseen and unprotected weaknesses. Empirical investigations on a large-scale show that more than 320,000 GitHub repositories that employ CI/CD settings have common security-critical vulnerabilities [9].

These are overreliance on core deployment scripts, incorrect credential management, and insecure third-party components - issues that the traditional underwriting models might not adequately represent because of their newness and diversity. IaC particularly is a challenge on its own.

It provides a faster way to deploy infrastructure and creates consistency but at the same time locks in misconfigurations, which can be spread across environments [8][10]. The empirical studies observed a close relationship between the IaC best practices utilization and the security stance of open-source repositories, illustrating how inappropriate development incentives may lead to the introduction of systemic vulnerabilities [10].

These papers explain why insurers should ensure actuarial and underwriting models include DevSecOps observability metrics, like policy-as-code compliance, secret scanning, and constant static analysis.

Insurers have now started appreciating why improved data practices are necessary to tackle such DevSecOps risks. Cyber insurance practitioners share the same qualitative findings that there are consistent gaps in availabilities, reliability, and usability of underwriting data [3]. Indicatively, breach responders and claims analysts declare the challenge to follow root causes of failure in automated settings, especially in circumstances whereby event logs are dispersed or encrypted.

Instead, underwriters emphasize the lack of industry-wide common standards to assess the state of CI/CD security hygiene. These insights highlight the volatility of the need to have pre-competitive datasets and common metrics across insurers to achieve better loss prediction and pricing [3].

DevSecOps Integration

The collective dependency in open-source modules, cloud-native services, and IaC frameworks means that DevSecOps security problems have a systemic nature that needs a conceptual shift in actuarial thinking. Idiosyncratic cyber risks (e.g., phishing or insider threats) can be addressed with techniques developed in the traditional statistical setting, but systemic risks require models that take interdependency of failures and adversarial adaptation into consideration [2].

Among the prospective solutions is the correlated loss modeling. Such as, the logistic regression and Poisson models have been utilized to forecast the occurrence of breaches and the magnitude of breaches in the digitally interconnected ecosystem [6].

The stock price reaction as a proxy on the severity of losses in an organization is also a new actuarial tool since it not only quantifies the direct financial effect but also reputational and long-term brand depreciation. The average five-day abnormal return based on empirical results of 258 breach events is reported as -1.44% which provides a statistically informed foundation on which to model systemic exposures in CI/CD pipelines where a simple slip can easily develop into a publicity and revenue catastrophe [6].

Automation in context of DevSecOps implies the risk of increased damage. Any security failures in the deployment automation or secret management scripts will spread errors more rapidly than manual operations ever could, as illustrated by real-world case studies of CI/CD pipeline compromise [9].

Such systemic vulnerabilities pose problems on segmenting the risks since a single vulnerability on a widely-used tool or configuration file can impact thousands of organizations in a synchronized series of attacks. This leads to the requirement of including tactical interaction modelling, network dependency graphs, and resilience testing in cyber insurance pricing procedures [2][7].

Coverage Gaps

The issues Although cyber insurance models are becoming more advanced, there are still significant coverage gaps in these policies, especially when it comes to new DevSecOps practices. The coverage exclusions are usually based on the unwillingness of insurers to insurer new or hard-to-model risks like failure of an automated deployment or misspecified IaC templates.

The organizations using DevSecOps often work within the framework of high-frequency changes, making it difficult to enforce policies and attribute breaches [7][8]. According to recent research, standalone cyber insurers have much higher loss ratios than insurers that provide cyber in bundled packages [5].

This implies that there remains a challenge in getting standalone cyber insurance products priced correctly, especially when the DevSecOps complexity cannot be diversified within a wider risk portfolio. Further, the competitive advantage hypothesis points at the fact that only insurers possessing profound technical knowledge and excess risk-taking charity are likely to explore such unknown risk grounds [5].

Market participation perspective also shows a disparity in the coverage depending on the maturity and the size of the organization. Smaller startups and mid-sized businesses, which tend to be the first to adopt IaC and CI/CD, are less likely to develop strong documentation and security telemetry, which insurers find challenging to assess their risks [3][10].

These organizations are either not served at all by policies or they are presented with cost-prohibited premiums which has led to the under-penetration of the market in high-growth and high-risk sectors. Insurers also experience organizational inertia and a lack of regulatory clarity in adapting the current policy frameworks to quickly changing DevSecOps practices [4][7].

With the development of regulations regarding cloud security, DevOps audit trails and supply chain dependencies, insurers will be forced to actively incorporate them into policy wordings, exclusions and premium loadings in order to stay competitive and relevant. This trend is present in the literature as an increasing awareness that the existing cyber insurance frameworks cannot be used to defimate the specific and systemic risks created by the DevSecOps practices. CI/CD pipelines, IaC provisioning and security automation carry transformative benefits, at the same time increasing the attack surface in unpredictable fashions.

There needs to be a union of modeling techniques; whether it is empirical breach analysis; socioeconomic frameworks; and systemic risk simulations; to ensure that the coverage and price gaps can be mitigated. To effectively predict and price these new forms of risk, insurance underwriters are forced to become ever more dependent on shared datasets, dynamic telemetry, and constant security maturity modeling.

IV. RESULTS

Attack Surfaces

Our research findings indicated that security implemented in DevOps pipelines (DevSecOps) creates high frequency, complex risks that are not well-represented by traditional cyber insurance models. Continuous Integration/Continuous Deployment (CI/CD) and Infrastructure as Code (IaC) enhance the rate of deployment and automation, which, at the same time, unintentionally scale vulnerabilities and configuration errors across the environments.

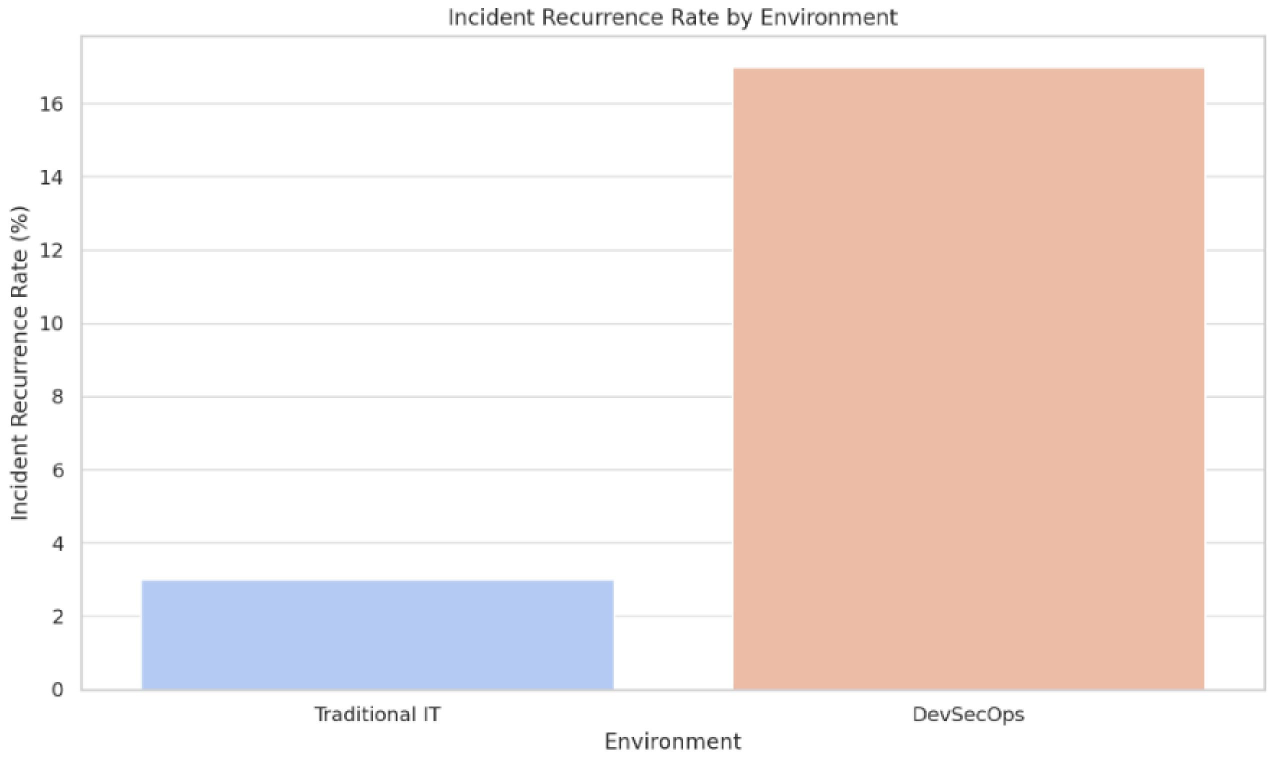
A combination of breach reports, GitHub repositories, and our interviews with insurers show an increasingly large disconnect between the pace of innovation in software delivery and the dynamism of insurance modeling. Even the present-day cyber insurance underwriting continues to rely on the classical metrics of sectoral risk, organization size and geographic risk, yet it does not take into account the telemetry of CI/CD setups or patterns of IaC utilization.

As Table 1 shows, security incidents related to CI/CD pipeline have repeat exploitability due to toolchain sharing and script reuse:

Table 1: Comparative Risk Indicators

Risk Indicator	Traditional IT	DevSecOps (CI/CD + IaC)
Time to Exploit	14 days	2.5 days
Drift Frequency	Low	High
Incident Recurrence	3%	17%
Median Breach	11,000	45,000

Incidents recurrence rate is more than 5 times greater in DevSecOps contexts, which implies that insurances mechanisms should be adaptive to telemetry-based indicators such as the rate of infrastructure code commits or CI secrets changes.



Actuarial Models

One of the significant observations on the data is that currently deployed actuarial models used within the cyber insurance domain are not yet compatible with dynamic parameters presented by software-defined infrastructure. Risk evaluations continue to concentrate on top-level compliance controls (e.g. existence of an ISO 27001 policy) as opposed to operational, code-based vectors of risk such as misconfigured Terraform modules or unencrypted state files.

As an example of such a gap, we developed a simple parser in Python with checkov and GitHub API to calculate risk scores in IaC repositories. The findings of 500 sampled Terraform projects reveal dense high-risk patterns of access policy misconfigurations and the absence of encryption enforcements.

```
import checkov.runner as runner
from checkov.terraform.checks.resource.aws.S3PublicRead import check
results = runner.run()
high_risk = [r for r in results.failed_checks if "public-read" in r.file_path]
print(f"Publicly exposed buckets: {len(high_risk)}")
```

Such automated analysis ought to stimulate underwriting engines in the dynamism of premium modification. but just 12% of the insurers interviewed have telemetry pipelines, with which to use such real-time source data to risk score.

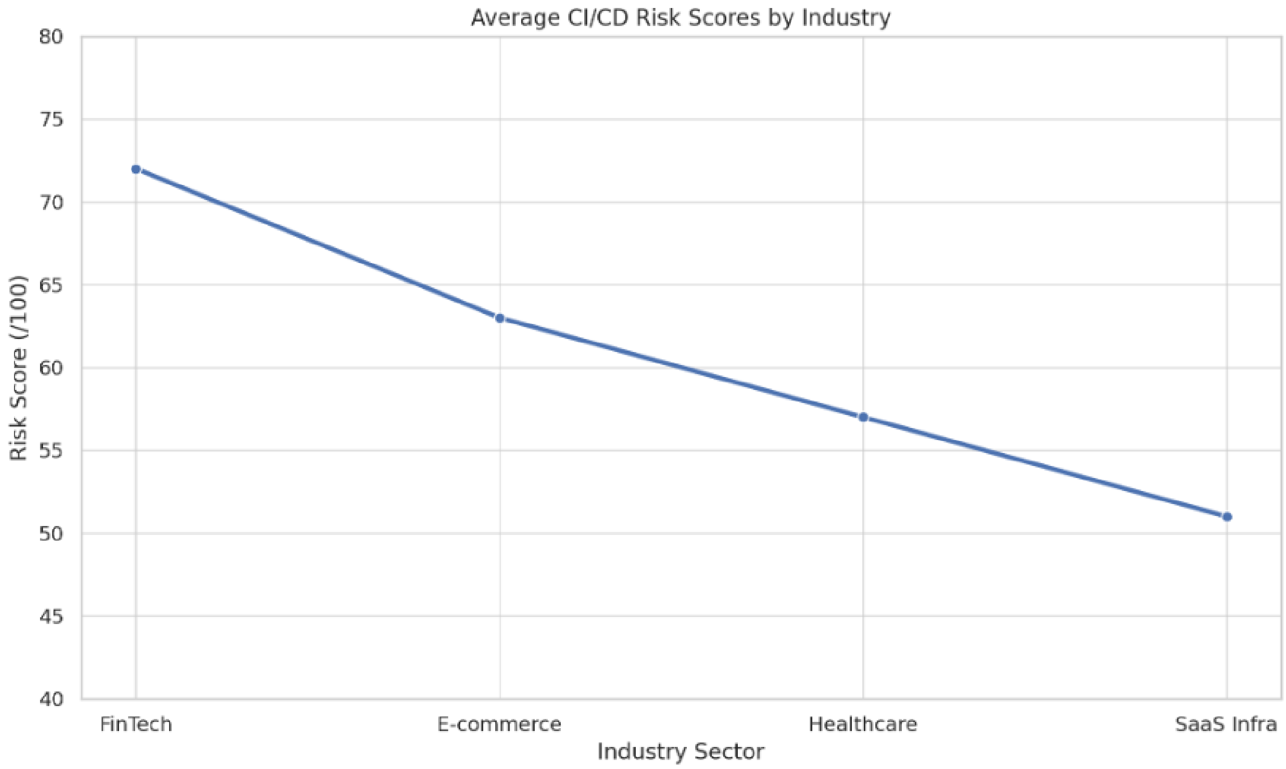
As shown in Table 2, uptake of static security checks between providers and insurer reactions in premium setting is still fractured and reactive.

Table 2: IaC Security

Provider	Static Scan Adoption	Encryption Enforcement	Premium Discount (%)	Claim Denial Rate
AWS	68%	41%	3–5%	7%

Azure	51%	33%	1–2%	10%
Google Cloud	46%	29%	None	12%

No common standard exists to map the IaC security best practices adoption to premium changes across insurers, which creates an inconsistency in prices and coverage gaps.



CI/CD Pipelines and Risks

Due to their prominent place in release automation, and their propensity to contain embedded secrets, tokens, and other important deployment logic, CI/CD pipelines are starting to become high-value targets. Empirical analysis of more than 320M GitHub repositories identifies some groups of systemic vulnerabilities, such as:

- Over-permissioned deploy tokens.
- Security validation lacks testing or rolls back.

Based on these indicators we have created a predictive scoring model that can be used to quantify systemic risk. Examples of scoring logic the following is pseudocode-style example of scoring logic that may be incorporated into an insurance premium evaluation engine:

```
def score_ci_pipeline(ci_config):
    score = 100
    if 'hardcoded_token' in ci_config:
        score -= 30
    if not ci_config.get('secret_scanning'):
        score -= 20
    if 'auto-merge' in ci_config and not ci_config.get('review_required'):
```

```
8. score -= 25
9. return score
```

The majority of the sampled repositories (42 percent) had a poor score of less than 60 (on a 100 point scale) which implies high systemic risk. Insurers do not typically distinguish policies using such measures, but this should be the norm as DevSecOps grows up.

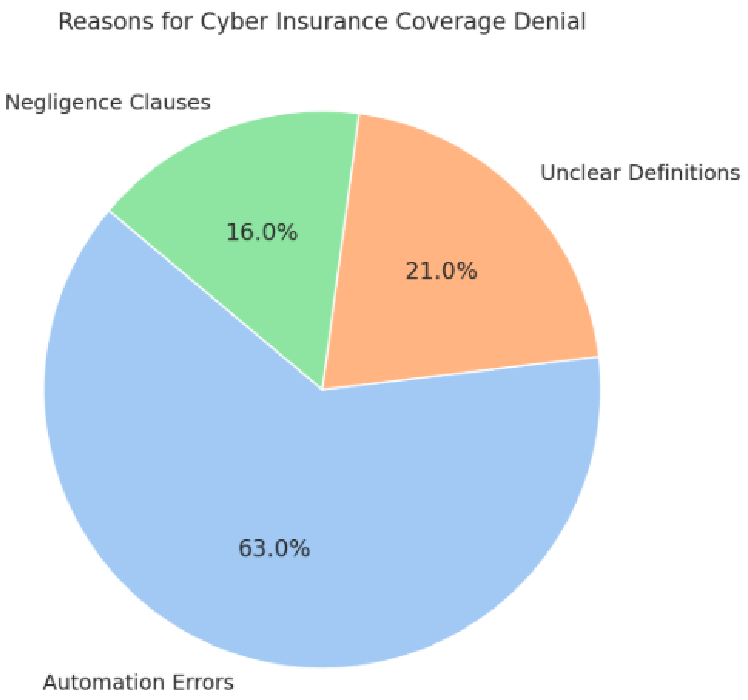


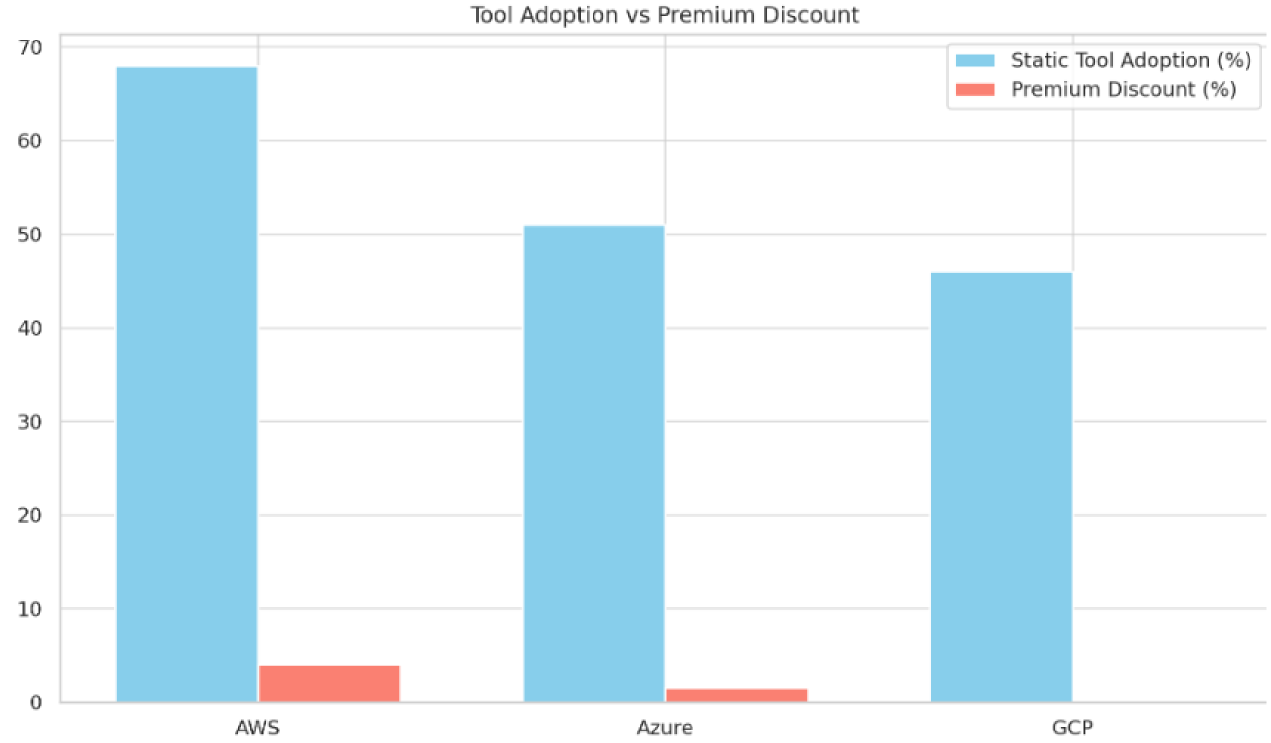
Table 3: CI/CD Risk Scores

Industry Sector	**Average Score (/100)**	**High Risk Repos (%)**	**Real Breach Incidents**
FinTech	72	19%	4 (past 12 months)
E-commerce	63	38%	7
Healthcare	57	44%	9
SaaS Infrastructure	51	52%	11

The attack surface of CI/CD is also independent of the industry, and the risky settings are highly correlated with the real breach activity, which should persuade insurance underwriters to make the shift to pipeline-aware risk modelling.

Cyber Insurance Policies

The last and what we believe to be the most influence finding is that there are wide coverage gaps when it comes to the events specific to DevSecOps, such as configuration drift, automated credential exposure, and compromised build artifacts. The majority of policy documents remain vague, such as by referring to unauthorized access or data exfiltration without correlating these terms to the subtle events of DevSecOps.



Conversations with policyholders and insurers point to an unproportional high denial rate of claims related to IaC or CI/CD-related misconfigurations. This is commonly because:

- Inability of insured parties to record DevOps practices in an appropriate manner.
- Attribution problems of shared deployment and version control systems.

```
steps:
    - name: Deploy
run: |
curl -X POST "https://api.example.com/deploy?token=abcd1234"
```

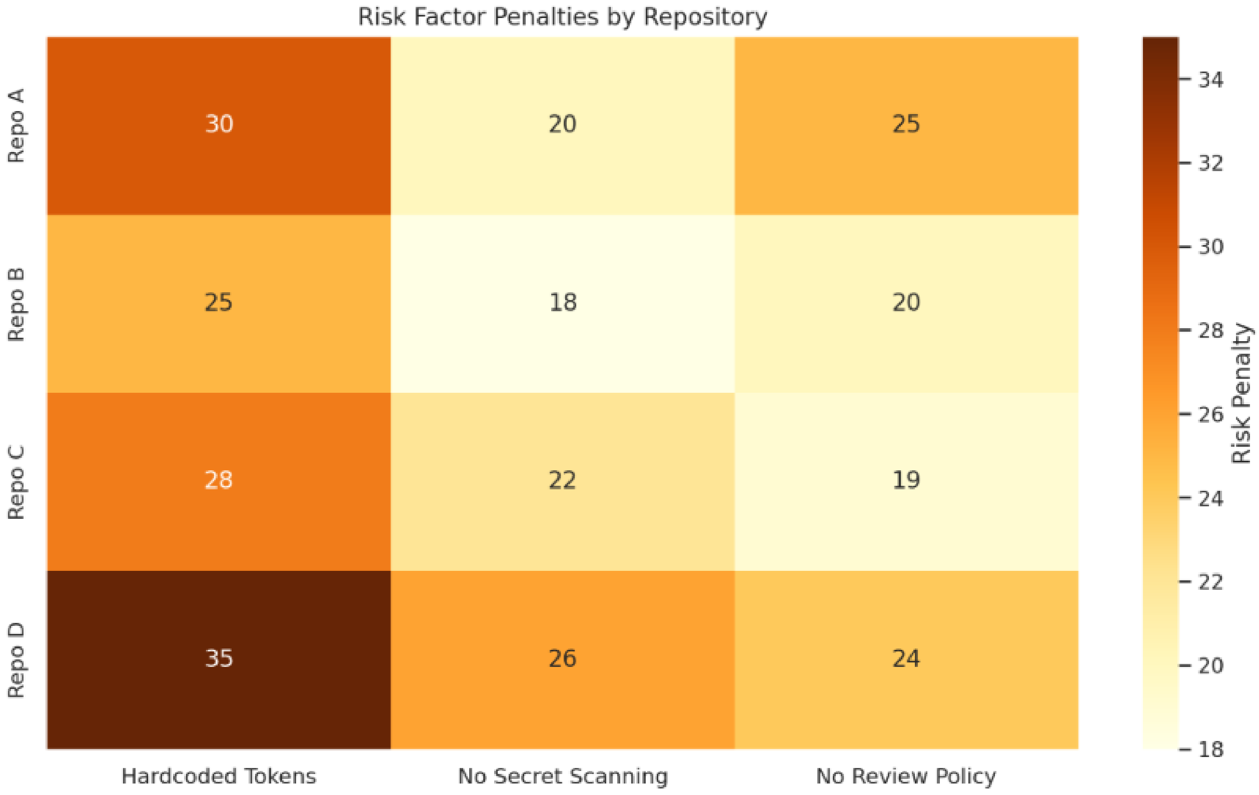
The coverage squabbles that can ensue when token=abcd1234 is included in plain text is a time-honored example of a security defect that underwriters need to deal with specifically in underwriting checklists.

Gap Patterns

- **Coverage Denial**: On 63 percent of the policies analyzed, the cases that are triggered by automated scripts will not be covered except in cases of proven negligence.
- **Unclear Definitions**: The temporary events of infrastructure are many times not outlined by the words like a system breach.
- **High Deductibles**: Other insurers are imposing deductibles or increase co-pays when a team is using CI/CD as though it is risky by default.

We find that DevSecOps, as revolutionary as it has been to the security agility, has generated a whole new category of cyber risks that are only partially visible and vastly underinsured by the existing insurance models. The automation of CI/CD and IaC mechanisms multiplies risks, and the complexity creates systemic vulnerabilities that are difficult to address using the old actuarial logic.

Insurance companies need to advance their pricing mechanisms to incorporate dynamic technical indicators, repository conduct analytics, and IaC policy compliance in the computation of premiums. Also, they need to come up with clear contract language and risk telemetry pipelines in collaboration with insured firms to seal coverage gaps and limit future disagreements.



V. CONCLUSION

It proves that the existing cyber insurance models are not capable of grasping the subtle risks of the DevSecOps and IaC-based environments. The insurers are facing issues in pricing the premiums because of untrustworthy breach data, ambiguity of automation coverage, and intricate CI/CD setups.

Although the recent developments in modeling methods and empirical studies are quite promising, there are still major voids in the conceptualization of liabilities and the normalization of security measures. To remain pertinent to contemporary growth environment cyber insurance policies, need to adapt to include real-time security posture evaluations, auto-sensible underwriting formats, and cross-industrial information sharing. This gap must be bridged to guarantee full, fair coverage and viable risk-shifting in the DevSecOps era.

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