Biosecurity

A Systems Perspective

Edited by Susan M. Hester, Lucie M. Bland, Edith Arndt, Sana Bau, James S. Camac, Evelyn Mannix, Raphaël Trouvé and Andrew P. Robinson

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Chapter 8

Incentives

Incorporating Incentives into Biosecurity Policies and Regulations

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8 Incentives

Incorporating Incentives into Biosecurity Policies and Regulations

Gary Stoneham, Susan M. Hester, and Arthur Campbell

ABSTRACT

Biosecurity systems and the activities undertaken within them are public goods—no one can be excluded from accessing them or forced to pay for them. As a result, markets that would otherwise indicate the optimal amount of risk mitigation do not evolve naturally. Because of this market failure, governments across the globe intervene in the movement of goods and people, typically with science-based regulations that rarely account for stakeholder behaviours. Biosecurity regulations that do not carefully consider stakeholder responses can deliver unintended and counterproductive policy consequences, potentially undermining biosecurity outcomes. Potential solutions to generate the efficient level of biosecurity effort would be to modify the markets in which biosecurity effort and activities are determined or to create markets where they are missing. This chapter considers the missing biosecurity market problem and efficient solutions, including developing an "incentive-approach" to biosecurity. It also considers laboratory-based economic experiments to assess and refine policy changes before they are introduced into the economy and the role of technologies in the design and implementation of incentive-compatible policies.

GLOSSARY

Incentives Inducements for individuals to take actions that they would otherwise not consider. Incentive-compatible policies align the actions of self-interested individuals with a broader policy objective.

Market Places where buyers and sellers meet to trade goods and services. It is where the price and amount traded are determined; where the basic questions of what should be produced, how it should be produced and for whom, are solved.

Market failure Situations where transactions do not allocate goods and services efficiently. A range of factors can lead to market failure, including public goods, externalities, missing or weak property rights, lack of competition, and transaction complexities.

Public goods Types of goods where use by one person does not prevent access or reduce availability to other people. Those consuming public goods cannot be stopped from accessing them or failing to pay for them. Examples of public goods include ecosystem services, national security, or street lighting.

Market design A method for creating rules and processes to organise transactions to achieve a defined outcome.

Game theory Allows the study of strategic behaviour between two or more agents when they have more than one strategy from which to choose and their choices affect the returns (i.e. payoffs) of another agent in the interaction.

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Experimental economics The testing and refining of incentive and information structures on human behaviour via economic experiments undertaken in a controlled environment (e.g. laboratory or field).
Actuarial pricing The principles applied to pricing of risk.
Principal-agent problems Occur where a task is delegated by a principal (who accrues the direct benefits of the task) to an agent (who bears the direct time and effort costs).
Alignment problems The differences that occur between how a principal and agent in an organisation would prefer a particular task to be done. Where alignment problems exist, there are potential gains to both parties from improving the incentives of the agent for undertaking the task.
Incentive-compatibility constraint A policy is "incentive-compatible" when each participant in their own interest makes decisions that are aligned with the objectives of the policy.

INTRODUCTION

In open, decentralised economies, decisions about goods and services produced and consumed are generally made by private individuals who implement their production and consumption choices through markets (i.e. places where buyers and sellers meet to exchange goods and services). For many goods and services, buyers and sellers transact through markets that harness competition between (1) consumers to determine who values the goods or services the most and (2) sellers to reveal who can supply items at the lowest cost.

Efficient markets identify the set of transactions that maximise value through a matching process between buyers and sellers. The prices revealed through markets identify the "best" use of resources (from a value-creation perspective), enable buyers to exercise their preferences between alternative goods, and encourage producers to supply goods and services at lower cost. In this way, markets create incentives (i.e. inducements) that encourage participants to take actions that maximise the value created from transactions.

While markets naturally evolve and work well for many goods and services (e.g. commodities, financial services, and travel), markets are missing in some domains of the economy, along with their embedded incentives. Markets are missing for many types of research, where new discoveries and ideas become freely available to all. Markets are also missing for many environmental goods and services, such as climate change mitigation, biodiversity conservation, and air and water filtration (Alvarado-Quesada, Hein, and Weikard 2014; Stoneham et al. 2003). In the latter example, landholders are rewarded for producing agricultural commodities but not ecosystem services (Teytelboym 2019) even though environmental services are highly valued.

There is no formal market for biosecurity activities. Investment in biosecurity effort is determined in markets for imported goods and commodities, but arguably these markets do not encourage the optimal level of biosecurity effort. While some costs of importing goods (e.g. shipping, product spoilage, damage, loss, and theft) are the responsibility of the importer, the costs of preventing and responding to pest and disease incursions are transferred to the citizens and the natural environment of the importing country. These costs do not apply to each import transaction but emerge as expected costs derived from the probability of pest or disease entry and the economic impact of these pests and diseases should they establish and spread.

Biosecurity is therefore a class of risk, but unlike other types of risk (e.g. loss or injury), it is not technically feasible (or it is prohibitively costly) to assign the costs of an outbreak to a specific importer. In this economic environment, importers under-invest in activities such as testing and screening imported goods for harmful pests and diseases, treating consignments, declaring relevant information, compensating for damages caused, and purchasing insurance against expected losses.

These and other worthwhile activities could be undertaken to reduce biosecurity risk, but they are not rewarded through the incentives embedded in existing markets. As such, missing incentives for biosecurity activities within existing markets do not encourage the efficient level of effort needed by importers to reduce biosecurity threats. Nor do they encourage consumers to select appropriate types and quantities of imported goods. In contrast, import markets create incentives for other desirable attributes of imports (e.g. quality or origin) through price premiums paid by consumers.

The absence of appropriate incentives means that some of the value created from transactions in imported goods is illusory. If flowers imported from a high-risk country cause the introduction of a serious pest, the costs imposed on the destination country could more than exceed the benefits derived by consumers. Where this is the case, such transactions reduce rather than increase gross domestic product, making citizens in the importing country "poorer". In contrast, goods that have relatively low biosecurity costs for the importing country increase national income and well-being, making citizens in both importing and exporting countries better off.

The current strategy adopted by many countries is for the government to identify the type and level of additional effort needed to reduce and respond to biosecurity risk (e.g. through regulations, inspections, surveillance, control, and research). Biosecurity activities are typically funded by taxpayers and implemented by government employees (or contracted agents), with the right level of investment defined as the "appropriate level of protection" (ALOP; see Chapter 2. Biosecurity Systems and International Regulations). Under this approach, it is the biosecurity agency that defines threat mitigation actions required for imported goods. In some instances, this could include offshore fumigation to remove disease risk, testing and reporting of symptoms, and in some cases prohibition of high-risk imports. These and other biosecurity interventions are implemented as regulations that are sanctioned under the World Trade Organisation.

The key problem with this approach is that government officers (or their agents) do not have access to all the information needed to allocate funds in a way that generates the highest returns. For example, governments do not have specific information on the costs of alternative imports that would lower biosecurity risks or the prices that consumers would be prepared to pay for these goods. This and other information needed to identify the efficient (i.e. "right") level of biosecurity effort is unevenly distributed among actors in the economy (i.e. asymmetric information) and some has commercial value such that those who hold relevant information are unwilling to reveal it (i.e. private or hidden information). The ALOP target adopted by many countries is formed in the absence of this information, such that it does not lead to the efficient level of biosecurity effort (i.e. biosecurity investment).

In this chapter, we explore two options to create incentives to improve the behaviour of biosecurity stakeholders and generate an efficient level of biosecurity effort. First, we outline how designing a biosecurity market using an actuarial levy (equivalent to an insurance premium) charged to importers could create a structural link between risk exposure and biosecurity funds. Second, we review how policies and regulations can be designed so that they embed appropriate incentives for stakeholder compliance, and we note the important role that technological advances can play in this process. Finally, we review the opportunities offered by experimental economics to assess and refine policy changes before they are introduced into the economy.

DESIGNING MARKETS FOR BIOSECURITY RISK

A potential solution to generate the efficient level of biosecurity effort would be to modify the markets in which biosecurity effort and activities are determined (e.g. markets for traded goods) or to create markets where they are missing. These approaches would create the incentives needed for producers and importers to invest in biosecurity activities and for consumers to select goods that mitigate biosecurity threats.

Markets for many goods and services evolve organically from the same selection process that is observed in nature (McMillan 2002). The rules and processes that define markets are refined over countless transactions and persist when they are perceived to be efficient and fair. An efficient market is one that maximises value created for buyers and sellers who engage in transactions, while fairness refers to the way markets distribute the value created from transactions. Markets do not promise to distribute value equally between buyers and sellers, rather, they distribute value in predictable and acceptable ways. Many variations on these rules and processes emerge in response to a range of complexities that are relevant to specific goods and services. As in nature, markets evolve in a competitive environment but must also allow collaboration, coordination, and cooperation where these and other forms of behaviour increase the value created from transactions.

Markets evolve in many domains of the economy, but markets may be missing or inefficient where the goods and services being transacted are public goods, property rights are weak or unenforceable, competition cannot be harnessed because of too few participants, or where complexities are present (e.g. policy, transaction, strategic, or timing complexities). Relatively recent advances in market design are now available to address some (but not all) of these issues to improve the efficiency of markets and create them where they are needed. These ideas and techniques, summarised by Roth (2002), have had a profound impact on the institutional landscape of the economy. Notable examples include the creation of matching markets for kidneys (Roth, Sönmez, and Ünver 2004), school and university admissions (Abdulkadiroğlu and Sönmez 2003; Roth and Sotomayor 1989), bespoke auctions to allocate and price mobile phone spectrum (Cramton 1995), network access (McDaniel and Neuhoff 2004), natural resources (Cramton and Soros 2007), environmental goods and services (Stoneham et al. 2003), and energy markets (Wilson 2002). These and other applications (see Roth 2018) expand the boundary of markets in the economy and create incentives to change the behaviour of self-interested individuals to align with broader national goals.

Market design has important implications for biosecurity, as biosecurity markets (and embedded incentives) could be created to reward importers and other stakeholders for their effort (Box 8.1). Applying this approach depends on a government's ability to design and implement a mechanism that efficiently prices biosecurity risk, such that importers face incentives to invest in the right type of biosecurity effort and consumers can purchase an appropriate portfolio of imported goods.

BOX 8.1. THE THREE STAGES OF MARKET DESIGN

Market design can be framed as a three-stage process.

1. Diagnosis

The absence of a market suggests that some impediment (referred to as complexity) diminishes the value that could be created from transactions (Arrow 1969). The first diagnostic phase of market design establishes the reasons why a market is inefficient or missing. While some complexities cannot be resolved at a fundamental level (e.g. public goods), other complexities including policy, transaction, strategic, and timing complexities can be identified and resolved.

Complexities include:

- Information problems (e.g. hidden information).
- Matching problems (e.g. identifying potential counterparties).
- Timing problems (e.g. where buyers and sellers do not arrive at the same time in a market).
- Coordination problems (e.g. where market participants must interact with others to discover the most efficient transactions).
- Strategic behaviour (e.g. when there are too few buyers or sellers, and the market is "thin").
- Synergy problems (i.e. the value of one item depends on other items).

2. Economic Theory

The foundation concepts for market design are framed by game theory. The task of the economist is to identify the specific rules and processes needed to overcome complexities that cause missing or inefficient markets in the first place (Hurwicz and Reiter 2006).

3. Experimental Economics

Experimental economics and test bed techniques (see Plott and Smith 1978) are available to test and refine markets to ensure they are efficient and achieve intended outcomes. In an economic experiment, human subjects are typically required to transact an abstract item under different sets of rules and processes (e.g. a designed market) to uncover the economic properties of the market, how the market distributes value between buyers and sellers, and any implementation issues. These experiments allow the rules and process of markets to be refined.

Although widely used in other domains of the economy, risk markets have not yet been created to manage biosecurity risk. In a recent paper, Stoneham et al. (2021) argued that the reason such markets have not evolved as they have for other classes of risk is that risk creators (i.e. importers of goods and inbound vessels and passengers) are not exposed to the financial losses of their actions. In the case of biosecurity, it is not practical (and in many instances not technically possible) to attribute financial losses arising from the introduction of pests and diseases to specific importers, vessels, and/or passengers. Under these circumstances risk creators pass on the financial consequences of their actions to taxpayers in the importing country such that there is no incentive for importers and other risk creators to take out insurance. It is this externality that causes market failure—not the characteristics of biosecurity risk.

Where it is possible to resolve the externality problem (such as through compulsory purchase of insurance) there are important advantages from incorporating insurance principles (i.e. actuarial pricing) into national biosecurity systems through a compulsory, actuarially determined biosecurity levy. Key among the advantages is that the price of biosecurity risk creates incentives for importers to find lower risk imports to secure lower premiums and for consumers to consider the cost of biosecurity risk when making purchases. These behavioural changes are of interest because they harness hidden information held by importers (about the source of lower-risk imports) and consumers (about their preferences) that is not available to biosecurity managers. When the type, quantity, and origin of imported goods are incorporated into risk-based insurance premiums, market transactions lead to the right type and level of biosecurity effort. There are also financial sustainability advantages from creating a dedicated pool of funds (through an actuarial levy) available to fund government biosecurity effort. This mechanism creates a structural link between risk exposure and funds available to respond to biosecurity incursions (see Chapter 7. Prepare, Respond, and Recover).

Incorporating insurance principles into biosecurity systems has profound implications for governments' ability to create incentives. A significant part of the missing incentive problem might be addressed by creating a mechanism that reveals the price of biosecurity risk. The architecture of this mechanism would draw on the same principles used to price other risks, such as those arising from fire and other natural disasters, threats to life and health, income variability, cyber security, and terrorism threats. However, the structure of the mechanism would need to be adapted to reflect the market complexities relevant to biosecurity. Where this is not possible, government intervention will be needed to design and create incentives and regulatory processes needed to achieve the appropriate level of biosecurity effort. Strategic investment in monitoring technologies will assist with this task (Box 8.2).

CREATING STANDALONE INCENTIVES

Principal-Agent and Alignment Problems

Where markets cannot be created, a second strategy is to design and create the incentive structures currently missing due to the missing market problem. This approach relies on widely understood economic principles developed to solve principal-agent problems (Jensen and Meckling 1976). These problems occur whenever control of a task is delegated to an agent by the principal. In the biosecurity context, the government (the principal) seeks to align the actions of self-interested agents (e.g. import businesses, passengers, farmers, and consumers) with the national interest. In this context, governments can encourage self-interested agents to change their behaviour by offering incentives (i.e. inducements) and/or sanctions through laws and regulations.

Principal-agent problems occur in all aspects of life where a task is delegated by a principal (who accrues the direct benefits) to an agent (who bears the direct time and effort costs). In many instances, this creates an alignment problem between how the principal and the agent would prefer the task to be done. The agent, by virtue of receiving few of the direct benefits of the task and bearing many of the direct costs in terms of time and effort, will always care less than the principal about generating higher benefits through exerting greater effort or time.

For example, a shop owner may employ a salesperson to assist customers in choosing the best product to meet their needs. The effort of the salesperson to assist the customer in finding the right product is important in convincing them to make a purchase, but the direct beneficiary of the sale is the store owner. As a result, the salesperson may not exert as much effort in generating sales as the store owner may wish. The store owner may recognise this issue and endeavour to incorporate incentives into the salesperson's compensation (e.g. sales quotas and associated bonuses) to improve their effort.

The presence of an alignment problem means there are potential gains to the principal and agent from improving the incentives of the agent for undertaking the task. In practice, a wide variety of formal and informal agreements between the principal and agent are used to improve how an agent undertakes a delegated task. These often involve interventions aimed at better aligning the goals of all parties. Examples include compensation schemes that reward employees for their performance through bonuses, equity in the firm and stock options; contracts between a provider of a good or service and the purchaser that reward the provider for better quality or timely provision; and insurance contracts with clauses that reward the insured for safe behaviour through no-claims discounts (as for car insurance). One of the oldest and most common alignment interventions are share-cropping arrangements between landlords and tenant farmers, where farmers pay landlords shares of the harvest. In this way, landlords and farmers both share the risks and benefits of the harvest.

A number of factors limit the degree to which an agreement can realise potential gains, for example, due to:

- *Strategic behaviour of principals and agents*: A salesperson may not engage with customers to provide advice or, when asked, may provide poor advice or unfriendly customer service.
- *Imperfect observation of behaviours*. The shop owner may not be able to observe the quality of the customer service the salesperson provides.
- *Verification and enforcement difficulties*: A contract specifying that the salesperson should receive a bonus if they provide good customer service may not be readily enforced by an outside party who cannot verify the quality of the customer service provided.
- *Acceptability of the agreement to both parties*: The shop owner and salesperson must both agree to the terms of an employment contract.

There are broadly two classes of constraints that limit what any agreement can achieve: participation constraints and incentive-compatibility constraints. In most settings, participation in any agreement is voluntary (i.e. neither party may be coerced into an agreement). Participation constraints require that both the principal and the agent anticipate sufficient benefits from entering into the agreement than what they expect not entering into the agreement. In cases where it is possible to walk away during an agreement at any interim stage, both parties need to anticipate sufficient ongoing benefits from the agreement. For example, when a worker accepts an employment contract, they anticipate being better off accepting the contract than remaining unemployed or searching for alternative work.

All actions chosen by the agent and the principal in an agreement must therefore be compatible with each party pursuing their self-interest. This means that the structure of an agreement needs to embody incentives for each party to follow their required actions. The rewards from following the agreement outweigh the punishments from deviating from the agreement. The set of constraints that require that the actions of each party be consistent with each pursuing their own self-interest are known as incentive-compatibility constraints. Incentive design principles allow economists to create incentives that result in outcomes that may otherwise not evolve in poorly functioning markets.

Incentives in Border Inspection

We illustrate these ideas through an inspection game between an importer and a biosecurity agency. In our stylised setting, the biosecurity agency designs a set of regulations to mitigate risk from the import of a product. In the inspection game, the importer chooses whether to comply or not comply with the regulations, and the biosecurity agency chooses the frequency at which it inspects imported consignments and the penalty for non-compliance.

Table 8.1 shows the net benefits to the importer, depending on whether they comply with the regulations and whether the biosecurity agency inspects the consignment:

- An importer who chooses to comply receives a net benefit of $100 – *Cost*, where $100 is the sales benefit of importing the product and *Cost* is the cost of compliance to satisfy biosecurity regulations. This net benefit does not vary with whether the consignment is inspected or not.
- If the importer chooses not to comply and is not inspected, the costs of compliance are avoided, and the importer receives a benefit of $100.
- If the importer is inspected, inspection may identify non-compliance with a probability of *Detect* and the importer incurs a *Penalty* (the import may be destroyed and/or the importer may pay a fine). The net benefit to the importer is therefore $100 – *Detect* × *Penalty*.

The incentive design problem for the biosecurity agency is to set the frequency of inspections (*Frequency*) and penalties (*Penalty*) in such a way that an importer will choose to comply with biosecurity regulations. If the importer chooses to comply with regulations, the importer anticipates a

TABLE 8.1
The Net Benefit to an Importer Depending on Their Probability of Compliance with Biosecurity Regulations and the Frequency of Inspection by a Biosecurity Agency.

	Importer	
Biosecurity agency	**Comply**	**Not comply**
Inspect	$100 – *Cost*	$100 – *Detect* × *Penalty*
Not inspect	$100 – *Cost*	$100

benefit of \$100 – *Cost* irrespective of whether an import is inspected for compliance. If the importer does not comply with biosecurity regulations, the benefit will depend on whether biosecurity regulators inspect the import and detect non-compliance. In this case, the expected benefit for the importer is \$100 – *Frequency* × *Detect* × *Penalty*.

For importers to comply with biosecurity regulations, the benefit from compliance must outweigh the expected benefits of non-compliance. The incentive-compatibility constraint for the biosecurity agency is therefore:

$$\$100 - Cost > 100 - Frequency \times Detect \times Penalty$$

The importer will comply provided that:

$$Frequency \times Detect \times Penalty > Cost$$

For a given level of detection (*Detect*) and compliance cost (*Cost*), the biosecurity system must set a frequency of inspection and penalty high enough so that this condition is met. A range of frequencies and levels of penalty can induce compliance. For example, if an inspection *Frequency* of 50% and a *Penalty* of \$1,000 satisfy this condition, so will a *Frequency* of 100% and a *Penalty* of \$500.

An importer, anticipating that it will need to comply with a biosecurity regulation, will weigh up choosing to import a product and complying with the regulation or taking an alternative course of action. If the alternative action (e.g. sourcing a product domestically) generates a net benefit of \$40, then the importer will import a product provided that its anticipated benefits from importing are better than the alternative. This is the participation constraint for the importer given by:

$$\$100 - Cost > \$40$$

This is satisfied in this example provided that:

$$Cost < \$60$$

The design of biosecurity regulations balances the benefits of trade with potential costs and risks of bringing in products that may cause harm to local industries, people, and the environment. These constraints place limits on how regulations may be designed if they are going to achieve participation and compliance by importers. These constraints may impact the design of biosecurity regulations in a number of ways:

- If the frequency of inspection is low, then the biosecurity system will need sufficiently high penalties for (detected) non-compliance. If inspections are expensive and can only be conducted at low frequencies, penalties must be high to ensure compliance. In practice, there is a limit to the size of the penalty that can be credibly imposed on a party (e.g. the total value of a company), which may limit how infrequent inspections can be.
- At the other extreme, if the highest frequency of inspection is 100%, the lowest penalty to ensure compliance is $\frac{Cost}{Detect}$. If breaches of the biosecurity regulation are not readily verifiable and the probability of detection is low, this will increase the size of the penalty required to ensure compliance.
- Biosecurity regulations that are readily verifiable may also impose significant costs on some importers, so much so that they may result in an importer choosing not to import a product (the high costs of complying results in the participation constraint not being satisfied). Alternative regulations that may be complied with at lower costs but are less readily detected may be preferable.

BOX 8.2. THE ROLE OF TECHNOLOGY IN MARKET AND INCENTIVE DESIGN

Many biosecurity decisions are made in the absence of accurate and reliable information. Strategic investment in technologies that improve information about the level, distribution, and spread of pests and diseases, the origin of biosecurity threats, the provenance of goods in the supply chain, transmission pathways, and treatment options is likely to have a profound impact on the efficiency and efficacy of biosecurity systems. For example, rapid development of vaccines and accurate tests have highlighted the importance of technology in managing COVID-19. Other technologies could be important in designing and implementing incentives, regulations, and exchange mechanisms (i.e. markets) to align the actions of individuals and organisations with national biosecurity objectives. Advances in computing, data analytics, machine learning, artificial intelligence, genomics, biological engineering, diagnostic capabilities, and epidemiology (Chui et al. 2020) are likely to have important implications for the type and effectiveness of mechanisms used by biosecurity agencies to manage biosecurity threats.

Experimental Economics and Incentive Design

An important innovation in the last 30 years has been the development and use of laboratory experiments for testing human behaviour. Experimental economics techniques (Nobel Prize Committee 2002; Plott and Smith 1978) can now be used to augment the incentive design process. Economic experiments provide a controlled environment to examine the effects of particular incentive and information structures on behaviour. Experiments can be used as a test bed for new ideas and to assess policies before wider implementation. For example, Australia's Department of Agriculture, Fisheries and Forestry (DAFF) and the Centre of Excellence for Biosecurity Risk Analysis (CEBRA) used economic experiments to test incentive-compatible protocols for pre-border regulation (Box 8.3).

An important set of assumptions used in the design of any incentive structure concerns how people will respond to a particular set of incentives. Commonly, it is assumed that individuals:

- Are highly sophisticated in how they process information and make choices.
- Have narrowly defined preferences that value outcomes that benefit themselves but place little value on how an outcome affects others.
- Are sophisticated in not only their own strategic reasoning but are also confident other people are similarly sophisticated in theirs.

These are strong assumptions because nobody exhibits behaviour that is perfectly consistent with these assumptions in all situations. The utility of these assumptions is that they are a robust predictor of human behaviour that provides a benchmark against which to measure actual behaviour. Economic experiments can be used to test whether actual behaviour differs systematically from what is assumed in the design of an incentive structure. Where behaviour deviates systematically from expectations, varying some aspect of the environment to move behaviour back to the direction of the benchmark can reveal which assumption is not being met.

Importantly, economic experiments can examine how incentive and information structures interact to change the decision making of experimental subjects. Imposing regulatory changes without carefully considering stakeholder responses can introduce counterproductive incentive structures and deliver unintended policy consequences that can potentially undermine biosecurity outcomes. Laboratory-based economic experiments offer regulatory agencies significant benefits as a safe, low-cost environment to assess and refine policy changes before they are introduced into the economy.

BOX 8.3. USING ECONOMIC EXPERIMENTS TO TEST INCENTIVE-COMPATIBLE REGULATIONS

Australia's DAFF and CEBRA used economic experiments to design and test incentive-compatible protocols for pre-border regulation (Rossiter et al. 2018). The aim of the project was to assess the incentives inherent in compliance-based inspection protocols and to select key parameter values that would encourage importers to reduce the likelihood of biosecurity risk material entering Australia (Rossiter et al. 2016).

The Compliance-Based Intervention Scheme (CBIS) was introduced by the Department in 2013 to a number of low-risk plant-based products (Robinson et al. 2012; Rossiter and Hester 2017). The CBIS was based on a continuous sampling plan (CSP) algorithm originally developed in the quality control literature (Dodge 1943; Dodge and Torrey 1951). In the biosecurity context, a CSP determines whether to inspect a consignment based on the recent inspection history of the pathway and parameters set by the pathway manager. The CSP rewards consistently compliant importers with reduced inspection rates.

The focus of the economic experiments was to assess the behavioural responses of importers to key parameters in two CSP algorithms (CSP-1 and CSP-3). Rossiter and Hester (2017) suggested that the less-forgiving CSP-1 algorithm might be preferable to CSP-3 when the consequences of biosecurity risk material passing through the border are high. The CSP-1 algorithm is also simpler to implement and more easily communicated to stakeholders (Rossiter et al. 2018).

Experiments were conducted with Australian university students, using well-established procedures for laboratory experiments in economics (Friedman 2004; Guala 2005). Experimental subjects assumed the role of importers and were required to make choices about their preferred supplier over time. Importers could choose four potential suppliers who were identical in all respects except for their transport cost, purchase cost, and the likelihood of biosecurity risk material being present in a consignment. A computer played the role of the regulator.

The experiment examined particular aspects of CBIS rules likely to be more difficult to assess in the field, namely:

- Different inspection rules from the CSP family.
- The level of information provided to stakeholders about the inspection rule.
- Feedback on an importer's performance under the inspection rule.
- Costs and penalties of being inspected and failing inspection.
- Allowing rule choice from a limited set of options.
- Importers' understanding of the rule.

Key findings from the experiments were that the CSP-1 and CSP-3 algorithms resulted in similar importer behaviours. Providing more information about the inspection parameters and the consequences of failing inspection led to better importer choices from the regulator's perspective. In addition, providing targeted feedback to importers supported behaviour consistent with improved compliance (Rossiter et al. 2018). These experiments led to changes in how border inspection rules are implemented in Australia, specifically around the level of disclosure about rules and how feedback on regulatory performance is provided to importers of plant-based products.

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- The public good nature of biosecurity means that efficient markets for biosecurity risk-mitigation activities do not evolve naturally, and associated incentives are missing.
- Governments impose biosecurity regulations because, without them, the behaviour of importers would not automatically lead to outcomes that promote national welfare.
- The right incentives could improve the behaviour of biosecurity stakeholders, either by creating an efficient, compulsory biosecurity risk market (e.g. through risk-based insurance premiums charged to importers) or by creating incentive-compatible regulations.
- Technology can play an important role in incentive-compatible policies.
- Economic experiments can provide robust guidance on how incentive-compatible regulations can be implemented in the real world.

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