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Comparative *ad hoc* analysis of phytosanitary efficiency in EU

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Abstract. The number of harmful plant pests and diseases intercepted in phytosanitary checks of plant materials during import and intra-community movement by EU member states in 1999–2008 were compared with import volumes, and the *ad hoc* phytosanitary efficiency indices were calculated. There were but minor significant differences in phytosanitary efficiency between the member states which had joined before 2004 and the new member states. Several factors, like raw material import volumes, geographic position and the island effect were found to explain differences in phytosanitary efficiency among the member states.

Keywords: Interceptions, harmful organisms, island effect, import inspection, plant health

INTRODUCTION

The European Union has a common policy in protecting the member states from adverse effects of harmful plant pests and diseases. The plant health regime includes common lists of harmful organisms, obligations to control imported and marketed plant products, to supervise production and take measures against harmful organisms.

A few quantitative analyses have been published on plant pest interceptions in European countries (Palmieri et al., 2005; Roques & Auger-Rozenberg, 2006), with no connection to efficiency in application of phytosanitary measures.

Differences among the phytosanitary capacities of the member states of the European Union have been cited as one of the major critical issues posing the biosecurity risk to the common market. Brasier (2005; 2008) has stated that assuming the import inspection protocols across the 27 member states are variable, control of plant imports into the European Union will inevitably operate at the level of the weakest member state. In an attempt to overcome the difficulties concerning comparison due to the objective differences between the member states, the current paper determines the factors affecting phytosanitary efficiency of the countries and introduces a rough *ad hoc* index of phytosanitary efficiency.

MATERIALS AND METHODS

The EU member states were categorized by membership status into old (accession before 2004) and new member states (accession in or after 2004) accordingly. The collective consumption expenditure data for 1999–2008 (European communities, 2009) per membership category was averaged and analyzed by *t*-test. The member states were ranked by the mean collective consumption expenditure per inhabitant. Analysis of Covariance was used to estimate if a) *Total imports* (consignments of unmanufactured i.e. raw material imported for input into the industrial production process, except living plants, tobacco and food, expressed in value in millions EUR) from 1999 to 2008, b) *the Collective consumption expenditure share per total imports*, or c) *Country* have an effect on the number of findings of Harmful Organisms (*HO*) (EUROPHYT, 2009). The variables were normalized by logarithmic transformation. Regression analysis of the number of noted *HO*s in comparison to the *Total imports* was performed to characterize the variation of the findings of *HO* in different member states, and to find out which are the conditional expectations of *HO* findings at a particular import level.

In order to eliminate the effect of the differences in trade levels, a phytosanitary efficiency index was calculated by dividing the number of *HO* findings into the *Total imports*. The indices of efficiency of countries were compared by one-way ANOVA. Three-way ANOVA was used to study the effect of a) the geographic position of the country (categorized according to whether the majority of the country is situated north or south of the 50th parallel North), b) the share of coastal border dominance (sea border dominance if the coastal border equals or exceeds 50% of the border and land border dominance if coastal border constitutes less than 50% of the state border) and c) membership category as an additional factor.

STATISTICA 8.0 software (StatSoft Inc.) was used for the calculations and for creating graphs and tables. After comparison of the collective consumption expenditure, Bulgaria and Romania were omitted from further analysis in the absence of data on their import volumes.

RESULTS AND DISCUSSION

Although no data is available about the national budgets of phytosanitary services, it may be assumed the expenses are proportional to the national governments' collective consumption expenditure (Fig. 1). The latter is an indicator, consisting of national expenses for management and regulation of society, provision of security and defence, maintenance of law and order, legislation and regulation, maintenance of public health, protection of the environment, research and development, and infrastructure and economic development. When comparing the collective consumption expenditure from 1999–2008 by member states, a significant difference in government expenses between the old and new member states ($t = 10.19$; $Df = 236$; $P < 0.001$) is obvious (see Fig. 1). This may lead to the conclusion that new member states have fewer resources available for biosecurity, which may result in introduction of harmful plant pests and diseases (*HO*) into the EU common market. In order to explore if the number of *HO* findings depends on factors *Country*, *Total imports* or *Collective*

consumption expenditure per total imports, the analysis of covariance was used. The share of collective consumption expenditure per annual imports can be exploited as a relative indicator for budgets allocated for provision of public services while the effect of incoming trade volume is eliminated, which is why it was essential to test the impact of this factor. Results of ANOVA indicate that only *Total imports* and *Country* proved to have a statistically significant effect on the number of reported findings (Table 1).

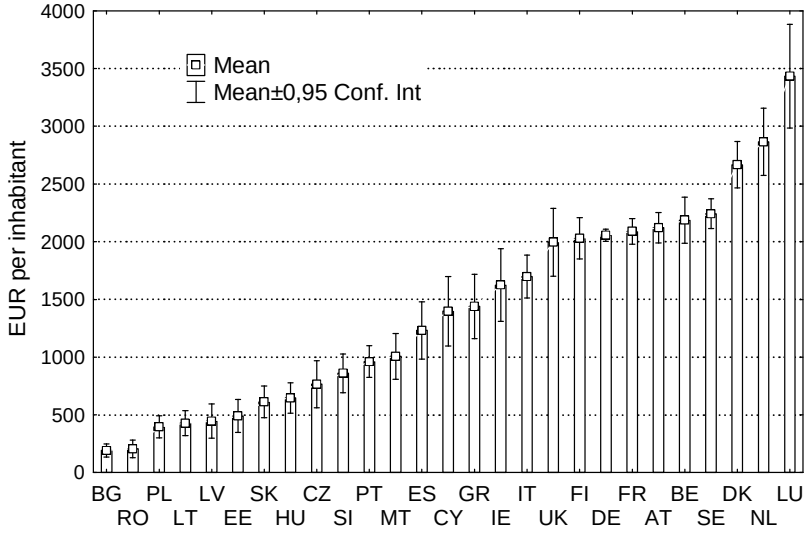

Figure 1. Mean collective consumption expenditure of EU member states in 1999–2008.

Table 1. Effect of multiple factors on findings of harmful organisms in EU, 1999–2008.

Effect	*SS*	*Df*	*F*	*P*
Total imports*	8.32	1	14.39	0.0002
Collective consumption expenditure per total imports*	0.99	1	1.72	0.19
Country	150.06	24	10.81	< 0.0001
Error	88.48	153		

* the log-transformed data.

Analysis of the data ascertains that there is a close and significant correlation between the number of harmful organisms found in phytosanitary inspections and the total imports (Fig. 2). Mean findings of harmful organisms can be predicted by the following equation:

$$\text{Log}(HO) = 0.69 \text{ Log } (Import) - 0.59, \ (F_{1,\,178} = 104.07;\ P < 0.001), \qquad (1)$$

while the model accounts for 36% of the variance ($R^2 = 0.36$). The results confirm that there tends to be a variation between member states in the outcomes of phytosanitary inspections, which up to a certain level can be explained by the differences in volumes of traded risk materials. In other words: the larger the plant imports, the more harmful organisms can be detected in phytosanitary inspections.

Without prejudice to the general character of the analysis, it can be concluded that

the data points above the regression line of the Fig. 2 represent phytosanitary efficiency tendency exceeding the average, while those below the mean regression line refer to lower efficiency. However, it should be pointed out that the statistical information is based on two independent databases and the results could be more consistent if the exact quantities of plant health imports were used instead of rough statistics on total import values.

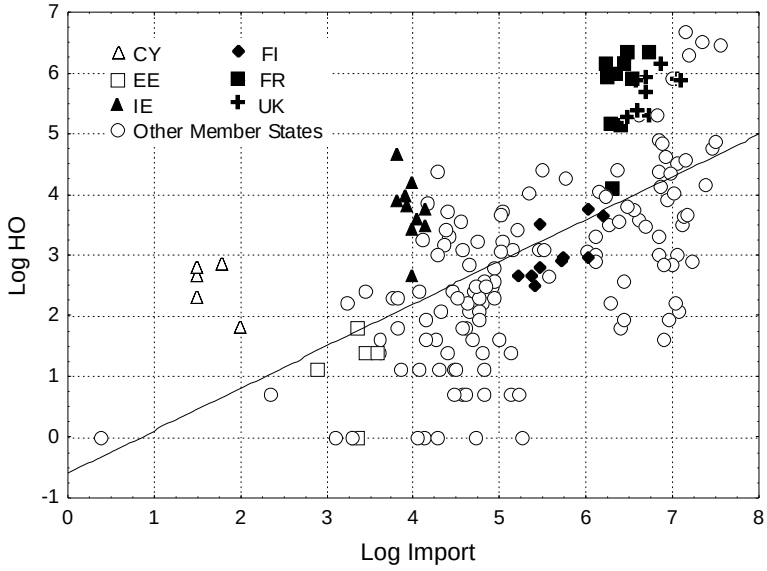

Figure 2. Correlation between the number of findings of harmful organisms (*HO*) by EU member states and total imports in 1999–2008 (annual data points per country).

The differences in the phytosanitary import inspection efficiency indices between countries, analyzed by ANOVA were significant ($F_{24, 155} = 22.68$; $P < 0.001$) (Fig. 3).

Post-hoc analysis reveals that for most EU member countries the efficiency indices are approximately on the same level, except for Cyprus, Ireland and France. There is no clear cut difference between the old and new member states. When comparing the data of the number of harmful organisms reported in old and new member states located in the northern and southern regions, the effect of geographic position was statistically confirmed $F_{1, 172} = 93.75$, $P < 0.0001$ by three-way ANOVA with the dominance of coastal border as an additional factor (Fig. 4).

It has been generally understood that the phytosanitary risks presented by imports normally increase with the distance from place of origin and with the degree of similarity of environmental conditions between the place of origin and the importing country. Imports from nearby regions are more likely to carry pests and diseases similar to the native species, due to the historical pathways which have distributed the range of plant pests across the region.

Several geographically isolated countries, such as islands or countries surrounded by high mountains or other impenetrable barriers, have maintained their unique ecosystems, the components of which are more vulnerable to damage by exotic pests (Ebbels, 2003). Brasier (2008) has pointed out that if this geographical advantage is

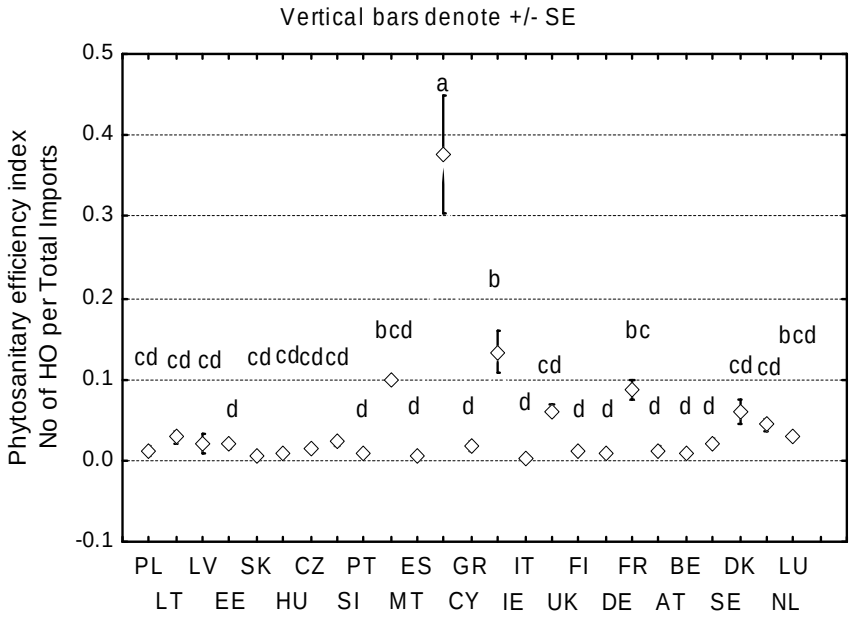

Figure 3. Comparison of the mean number of reported harmful organisms (*HO*) per total imports in million EUR by EU Member States. Different letters indicate significant differences by Tukey HSD test ($P < 0.05$).

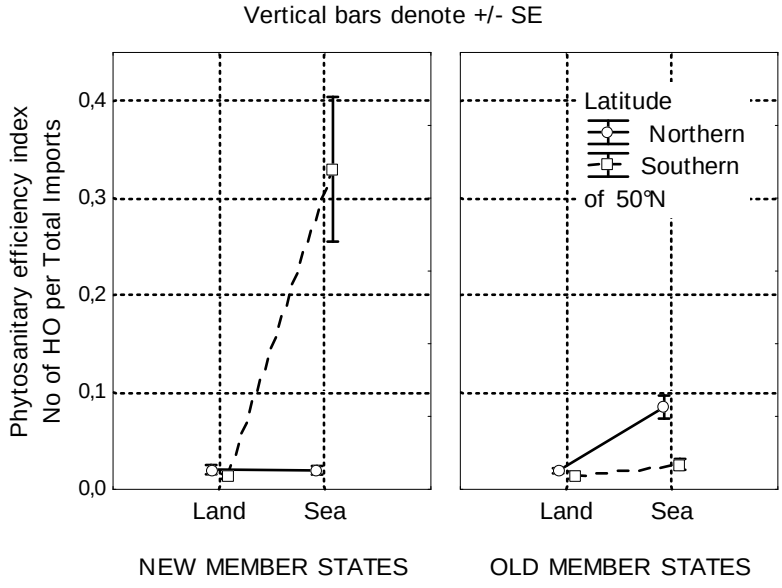

Figure 4. Influence of EU membership category, Geographic position (latitude) and Coastal border dominance on the number of reported harmful organisms (*HO*) per Total imports. 'Land' – coastal border < 50%; 'Sea' – coastal border ≥ 50%;
Old member states – Accession to EU before 2004;
New member states – Accession to EU on 2004.

recognized by the national phytosanitary services, more stringent measures and actions are applied, which may result in higher ratio of the pest findings to the same level of imports. We may call this phenomenon an 'island effect', illustrated in our study by the influence of coastal border dominance interacting with geographic position and the member state category on Fig. 4.

It is possible that new northern member states have not yet fully taken advantage of the island effect, to protect their ecosystems and plant production. However, there is no evidence that any phytosanitary system in the EU is capable of detecting all the harmful organisms in the plant trade. Accordingly, the general preparedness for eradication actions should be maintained in every country when new pathogens and pests are found, even after the most diligent enforcement of inspection protocols.

CONCLUSIONS

- The differences between the findings of harmful organisms can be explained to a moderate extent (36%) by differences in import volumes.
- Only a few member states have an above average level of harmful organism findings.
- Unexpectedly, higher phytosanitary efficiency cannot be attributed to the old member states exclusively.
- The phytosanitary capacity can be characterized by several other factors, such as geographic position and coastal border dominance of a particular country.
- The coastal border effect, which is also referred to as the "island effect", might be taken into greater consideration to promote higher security regarding non-native plant pests and diseases.

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