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# TAX BURDEN AND INNOVATION ACTIVITIES: THE INTERRELATION PROBLEM

**Abstract.** *This article provides a study of the theoretical and applied aspects of the relationship between tax burden and innovation activities. The hypothesis of the transmission mechanism between tax burden and innovation activities might be illustrated by the following logical chain: Tax burden ➔ Tax incidence ➔ … ➔ Innovation activities. It is reasonable to interpret tax burden and tax incidence relationship in terms of the approach of «losses-benefits». This approach creates a theoretical basis for explaining not only the reversed, but also the direct link – a situation where the increase of tax burden (up to a certain optimal amount) does not limit innovation activities. An attempt is made to evaluate the closeness of this relationship between tax burden and innovation activities in EU countries and Ukraine. For the calculation based on panel data from 27 EU countries we used the information of eight parameters, six of which are indicators of tax burden, and the last two – indicators of innovation activities. The tax burden in the EU, as defined by the percentage of all collected taxes to GDP, and the share of direct taxes are closely related to two innovation activities indicators – innovation activities index and the share of expenditure on innovation activities in GDP. Our findings in the area of the relationship between indicators of tax burden and innovation activities in Ukraine give grounds to draw the following conclusions: this relationship is unlikely to exist or, if it exists, it is inverse, i.e. an increase in the tax burden, (as the share of total taxes in GDP and as the share of indirect taxes in GDP) limits the volume of innovation activities. The conclusions stress the importance of the investigation of the relationship between tax burden and innovation activities for the Government tax management decisions.*
**Keywords:** *tax burden; tax incidence; innovation activities; tax burden and innovation relationship model; state management.*
**JEL Classification:** *E10, E62, H22, H39, O31, O57*

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**ПОДАТКОВЕ НАВАНТАЖЕННЯ ТА ІННОВАЦІЙНА ДІЯЛЬНІСТЬ: ПРОБЛЕМА ВЗАЄМОЗВ'ЯЗКУ**
**Анотація.** У статті розкриваються теоретичні й прикладні аспекти взаємозв'язку податкового навантаження та інноваційної діяльності. Презентовано підхід до оцінювання характеру й щільності цього зв'язку у країнах ЄС і Україні. Визначено, що залежність між податковим навантаженням та інноваційною діяльністю має ключове значення для прийняття управлінських рішень у податковій сфері.
**Ключові слова:** податкове навантаження, інноваційна діяльність, державне регулювання.

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**НАЛОГОВАЯ НАГРУЗКА И ИННОВАЦИОННАЯ ДЕЯТЕЛЬНОСТЬ: ПРОБЛЕМА ВЗАИМОСВЯЗИ**
**Аннотация.** В статье раскрываются теоретические и прикладные аспекты взаимосвязи налоговой нагрузки и инновационной деятельности. Предложен подход к оценке характера и тесноты этой связи в странах ЕС и в Украине. Определено, что зависимость между налоговой нагрузкой и инновационной деятельностью имеет ключевое значение для принятия управленческих решений в налоговой сфере.
**Ключевые слова:** налоговая нагрузка, инновационная деятельность, государственное регулирование.

**Introduction.** An assumption that innovators are entities of the economy connected with innovation activities who ought to react to tax burden changes is quite simple and realistic. The problem of the relationship between tax burden and innovation activities becomes obvious and shaped if we try to answer the following additional questions: 1) if this relationship has mediating links; 2) in terms of direction what nature has this relationship (direct or inverse); 3) if there are any differences in this relationship implementation in countries with different levels of development; 4) in what way a government can use the information about this relationship to make management decisions. In this article we make an attempt to answer mentioned questions.

The **purpose** of this article is to specify theoretical grounds of tax burden and innovation activities relationship as well as to analyse this relationship in order to justify the necessity of its consideration by the government while making management decisions.

**Brief Literature Review.** All macroeconomic scholars who emphasise the problem of tax influence on the general economic equilibrium and economic growth are involved in studying the tax burden and innovation activities relationship. Among them are Ch. Blankart (2006) [1], Buchanan, J. M. (2006) [2], St. J. Entin (2004) [3], Harris R. (2009) [4], R. A. Musgrave (1984) [5], Stiglitz, J. E. (2000) [6], U. Thiethen (2001) [7] et al.

The tax system structure and its influence on the Ukrainian economic condition is studied in works by such Ukrainian economists as Z. Varnalii (2008) [8], T. Vakhnenko (2001) [9], V. Heiets (2007) [10], A. Sokolovska (2006) [11], L. Tarangul (2003) [12], N. Frolova (2004) [13] et al.

**Results.** The answer to the question about mediating links in the relationship between tax burden and innovation activities ought to be positive. At least one link exists between tax burden and innovation activities – tax incidence or excess tax burden becomes such a link. Other links might be a focus of special research. If our assumption has grounds, then the hypothesis of the transmission mechanism might be illustrated by the following logical chain: *Tax burden* ➤ *Tax incidence* ➤ *...* ➤ *Innovation activities.*

Some grounds for differentiation of the notions «tax burden» and «tax incidence» could be found already in the works by D. Ricardo [14]. Section 8 «On Taxes» of his well-known work «On the Principles of Political Economy and Taxation» contains an idea that all taxes impede capital accumulation, if taxation takes place while the production increases or wasteful consumption decreases. In fact, it deals with some disproportion that can be associated with «tax incidence».

In the present macro-financial theories there are different approaches to the interpretation of tax burden and tax incidence. In order to distinguish between these concepts (and events), the renowned scholar of macro-financial science of the twentieth century R. A. Musgrave focuses on the so-called «echo» (further reparation). Its essence lies in the fact that, on the condition that the reaction of taxpayers to tax changes (in the form of changes in taxpayers' behavior and choices), taxes are as if «transferred» onto other dependent economic entities. The first links of the echo are: changes in job offering (for income taxes), new advantages for certain goods (for excise taxes), replacing capital by work (for taxes on capital) [5].

While the tax burden is associated with the necessary collection of income, in terms of the public goods and services financing, tax incidence is non-formalized and often an implicit additional tax burden as a result of «echo».

An alternative to the approach based on the idea of differentiation is the identification of tax burden and tax incidence. In particular, this approach is implemented in the work by the German researcher U. Thiethen and Ukrainian researchers Mel'ota J. and T. Vakhnenko [7] for finding causes of the shadow economy in Ukraine. In the econometric model the mentioned authors used variables «direct tax burden» and «indirect tax burden», which are estimated by the aggregate tax rate – the share of budgetary revenues of direct and indirect taxes in GDP. It could be noticed that these parts are primarily a manifestation of aggregate tax burden. However, given the fact that actually the shadow economy is a total distortion of entities' economic choice and display of macroeconomic disproportion, such an approach does not fundamentally contradict the idea of differentiation of the tax burden and tax incidence.

In our view, it is reasonable to interpret tax burden and tax incidence relationship in terms of the approach of «losses-benefits». It is this approach that further makes it possible to come to the issue of innovation activities intensity. Note that quite often a different approach is used – «from the standpoint of market equilibrium». In particular, this «from the point of equilibrium» explanation of tax burden and the tax incidence relationship was emphasised in the work by S. Entin (Entin, 2004) [4].

The formula set out below, in our opinion, reflects tax burden and tax incidence relationship in terms of «losses-benefits» theory (Figure).
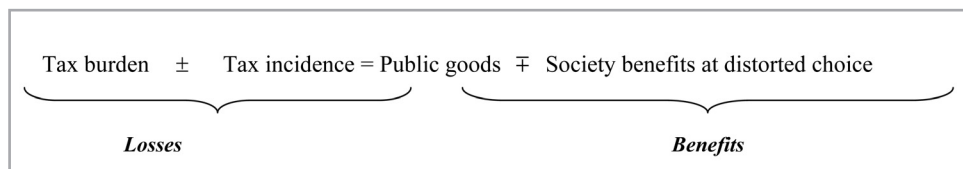


Tax burden ± Tax incidence = Public goods ∓ Society benefits at distorted choice

*Losses*                    *Benefits*

*Fig.* **Tax burden and tax incidence relationship**
*Source:* Composed by the authors

The main economic content of the formula shown above is exposed in the following provisions:
- balancing of the society losses and benefits from taxes is connected to the tax incidence; the tax incidence increase («+») causes a reduction in benefits under the influence of changes in the economic agents choice («-»), and, conversely, a tax incidence reduction («-») causes an increase in benefits («+ «),
- tax burden – losses of taxpayers income in the form of taxes paid - correlates with public goods, that is society benefits created with funding from taxes.

The formula in Figure is, among other things, an attempt to answer the second question from the set formulated at the beginning of the article – what nature (direct or inverse) tax burden and innovation activities relationship has in terms of direction.

The «losses-benefits» approach creates a theoretical basis for explaining not only the reversed, but also the direct link – a situation where the increase of tax burden (up to a certain optimal amount) does not limit innovation activities. The latter is an undeniable society benefit, that is connected to the growth of wealth and prosperity. The presence of a direct link between tax burden and innovation, according to the logic of the proposed approach, can be explained by the consistently positive choice of economic entities for these activities, despite some increase in tax burden. We assume that the relationship between tax burden and innovation activities is a nonlinear function similar to the Laffer curve.

We are trying to determine how realistic the assumption is about the existence of direct and inverse relationship between tax burden and innovation activities. It can be tested by calculation. To answer the third question we estimated the relationship between different indicators selected to assess tax burden and innovation activities in EU Member States and Ukraine.

For the calculation based on panel data from 27 EU countries we used the information [15] on the value (for two post-crisis years – 2010 and of 2011) of eight parameters, six of which are indicators of tax burden, and the last two – indicators of innovation activities:

| | |
|---|---|
| - the total tax revenue into budget (including social contributions) as % of GDP – | $\dfrac{T'_{total}}{Y}$ |
| - the total tax revenue (excluding social security contributions) as % of GDP – | $\dfrac{T_{total}}{Y}$ |
| - budget revenues from direct taxes as % of GDP – | $\dfrac{T_{direct}}{Y}$ |
| - budget revenues from indirect taxes as % of GDP – | $\dfrac{T_{indirect}}{Y}$ |
| - taxes on labour as % of GDP – | $\dfrac{TL}{Y}$ |
| - taxes on capital as % of GDP – | $\dfrac{TK}{Y}$ |
| - expenditure on innovation as % of GDP – | $\dfrac{IE}{Y}$ |
| - composite index of innovation [*] – | $SII$ |

[*] *Index of innovation* is a composite index to determine the level of innovation activities for EU countries and 10 major global competitors based on a set of 25 indicators.

According to the matrix of pairwise correlations (calculated using the data [15; 16; 17]), the most significant relationships (R75%) are relationships between:

- the share of total taxes (including social contributions) in GDP ($\frac{T'_{total}}{Y}$) and overall innovation activities index (SII) - R = 0,78,

- the share of total taxes (including social contributions) in GDP ($\frac{T'_{total}}{Y}$) and expenditure on innovation activities in GDP - ($\frac{IE}{Y}$) - R = 0,76,

- the share of direct taxes in GDP ($\frac{T_{direct}}{Y}$) and overall innovation activities index (SII) - R = 0,75.

Relationships between all studied variables are direct, which means unidirectional changes in innovation activities and tax burden indicators. The latter can be interpreted in terms of the «loss-benefits» approach as tax incidence reduction and increase in society's «innovation benefits» against tax burden increase.

To assess the *essentiality* of the relationships (distinguished as a result of pairwise correlations matrix construction) we used the *analytical groupings* method. Presented in Table 1 are analytical groupings, used to assess the *essentiality* of the relationship between tax burden and innovation activities indicators in EU countries.

involves the calculation of the total variance $\sigma^2$, intergroup variance $\delta^2$, correlation ratio $\eta^2$ and application of correspondence criteria according to the Table 1 of critical values give grounds to the following generalizations:

• The tax burden in the EU, as defined by the percentage of all collected taxes to GDP, and the share of direct taxes are closely related to two innovation activities indicators – innovation activities index and the share of expenditure on innovation activities in GDP,

• The relationship between proportion of the direct taxes and innovation activities index appeared to be the closest. By contrast, the relationship between total taxes and innovation activities index is slightly lower. This can be interpreted as some weakening caused by indirect taxes and social contributions.

To assess the relationship between indicators of tax burden and innovation activities in Ukraine we used the following database (Table 2). This database does not contain the composite index of innovation activities *(SII)* because in Ukrainian statistics it is not calculated.

The matrix of pairwise correlations of variables describing tax burden and innovation activities in Ukraine proved the significance (R>75%) of the relationships between these variables:

$$\frac{T'_{total}}{Y} \text{ and } \frac{IR}{Y}, \frac{T_{indirect}}{Y} \text{ and } \frac{IR}{Y}.$$

The most significant relationships (between indicators of tax burden, both for total and for direct taxes, and the amount of research and developments) turned to be inverse in terms of direction. The latter can be interpreted as a reflection of the likely reduction in innovation activities caused by growth of total taxes and indirect taxes.

In order to construct an adequate model that can characterize the relationship between indicators of tax burden and innovation activities (based on the Ukrainian data), time-series variables (see Table 2) were tested by the test of a unit root.[**] Verification showed that it was impossible to construct an adequate model based on the initial data and it was necessary to correct the initial data. In order to correct it we used the method of first differences (augment) – ADF-test of the corresponding variables.

When we attempted to construct a model of the pairwise regression parameters of tax burden indicators and innovation indicators and used adjusted data, the obtained results showed no significant relationship (R = 3,5%). Instead, when we dealt with non-adjusted data, which does not give reliable results, we obtained high indicators of significance. Those indicators were enhanced by constructing a model with one year (-1) and two years (-2) lags. Certainly, lag usage when dealing with short data series (which is our case) reduces the findings reliability.

**Tab. 1: Analytical groupings to assess the essentiality of indicators of the relationship between tax burden and innovation activities in EU countries**

| Intervals according to tax burden | Number of countries | Innovation indicator value | The average value of innovation group indicators |
|---|---|---|---|
| Analytical groupings to assess the essentiality of the relationship between $\frac{T'_{total}}{Y}$ and *SII* | | | |
| 26,00 - 33,00 | 10 | 0,263; 0,233; 0,221; 0,243; 0,286; 0,566; 0,348; 0,392; 0,278; 0,472 | $\frac{3,300}{10} = 0,330$ |
| 33,10 - 38,00 | 9 | 0,426; 0,319; 0,504; 0,411; 0,622; 0,332; 0,708; 0,503; 0,588 | $\frac{4,412}{9} = 0,490$ |
| 38,10 - 48,10 | 8 | 0,591; 0,578; 0,432; 0,678; 0,609; 0,559; 0,734; 0,697 | $\frac{4,878}{8} = 0,610$ |
| $\sum$ | 27 | 12,59 | $\frac{1,430}{3} = 0,477$ |
| Analytical groupings to assess the essentiality of the relationship between $\frac{T'_{total}}{Y}$ and $\frac{IE}{Y}$ | | | |
| 26,00 - 33,00 | 10 | 0,86; 0,59; 0,65; 0,48; 0,66; 1,72; 0,60; 1,36; 0,75; 2,01 | $\frac{9,66}{10} = 0,97$ |
| 33,10 - 38,00 | 9 | 1,54; 0,69; 0,49; 1,71; 1,76; 1,19; 2,82; 1,46; 2,28 | $\frac{13,93}{9} = 1,55$ |
| 38,10 - 48,10 | 8 | 1,95; 2,77; 1,26; 3,84; 2,03; 2,24; 3,38; 3,08 | $\frac{20,54}{8} = 2,57$ |
| $\sum$ | 27 | 44,13 | $\frac{5,08}{3} = 1,69$ |
| Analytical groupings to assess the essentiality of the relationship between $\frac{T_{direct}}{Y}$ and SII | | | |
| 4,5 – 9,0 | 11 | 0,263; 2,233; 0,286; 0,243; 0,472; 0,278; 0,411; 0,221; 0,332; 0,503; 0,348 | $\frac{3,588}{11} = 0,326$ |
| 9,1 – 15,0 | 11 | 0,426; 0,392; 0,708; 0,504; 0,559; 0,566; 0,591; 0,578; 0,319; 0,588; 0,432 | $\frac{5,661}{11} = 0,515$ |
| 15,1 – 29,9 | 5 | 0,622; 0,678; 0,609; 0,734; 0,697 | $\frac{3,340}{5} = 0,668$ |
| $\sum$ | 27 | 12,59 | $\frac{1,509}{3} = 0,503$ |

*Source:* Composed by the authors

The results of the study on tax burden and innovation activities indicators using the analytical groupings method, which

[**] As it is known, only this test check guarantees the construction of a model which can give the reliable findings.

Tab. 2: **Database to assess the relationship between tax burden and innovation activities in Ukraine**

| Year | Total tax revenues in GDP $\dfrac{T'_{total}}{Y}$ | Direct taxes in GDP $\dfrac{T_{direct}}{Y}$ | Indirect taxes in GDP $\dfrac{T_{indirect}}{Y}$ | Expenditure on scientific and technical work in GDP $\dfrac{IE}{Y}$ | The volume of scientific and technical work in GDP $\dfrac{IR}{Y}$ |
|---|---|---|---|---|---|
| 1999 | 19,27 | 8,27 | 8,47 | 0,99 | 1,21 |
| 2000 | 18,41 | 8,28 | 7,69 | 1,03 | 1,14 |
| 2001 | 17,98 | 8,35 | 7,23 | 0,97 | 1,13 |
| 2002 | 20,10 | 8,96 | 8,73 | 1,33 | 1,11 |
| 2003 | 20,32 | 10,01 | 7,93 | 1,14 | 1,24 |
| 2004 | 18,30 | 8,51 | 8,16 | 1,31 | 1,19 |
| 2005 | 23,09 | 9,60 | 11,37 | 1,35 | 1,13 |
| 2006 | 23,11 | 9,00 | 12,17 | 1,13 | 1,00 |
| 2007 | 22,38 | 9,60 | 11,04 | 1,50 | 0,90 |
| 2008 | 23,96 | 9,89 | 12,32 | 1,27 | 0,90 |
| 2009 | 22,78 | 8,49 | 12,32 | 0,87 | 0,90 |
| 2010 | 21,66 | 8,44 | 11,38 | 0,74 | 0,90 |
| 2011 | 25,70 | 8,86 | 13,40 | 1,10 | 0,80 |
| 2012 | 24,14 | 8,79 | 13,50 | 0,81 | 0,80 |

*Source:* Composed by the authors using the data [18; 19]

The results of constructing a model of the relationship between the indicators of research and development ($\frac{IR}{Y}$) and two indicators of tax burden $\frac{T'_{total}}{Y}$ and $\frac{T_{indirect}}{Y}$ (based on Ukrainian data) are:

| The equation of the regression model: | Statistical indicators of the quality of the model |
|---|---|
| $\dfrac{IR}{Y} = 2.58 - 0.025\,\dfrac{T'_{total}}{Y} - 0.02\,\dfrac{T'_{total}}{Y}(-1) - 0.02\,\dfrac{T'_{total}}{Y}(-2)$ | *Adjusted R-squared=**0,8**; Durbin-Watson stat=1,24; Prob* $\dfrac{T'_{total}}{Y}$ *= 0.0490;* <br><br> *Prob* $\dfrac{T'_{total}}{Y}$ *(-1) = 0.0820;* <br><br> *Prob* $\dfrac{T'_{total}}{Y}$ *(-2)= 0.0438; Prob(F-statistic)= 0.000676* |
| $\dfrac{IR}{Y} = 1.79 - 0.027\,\dfrac{T_{inder}}{Y} - 0.0136\,\dfrac{T_{inder}}{Y}(-1) - 0.036\,\dfrac{T_{inder}}{Y}(-2)$ | *Adjusted R-squared=**0,90**; Durbin-Watson stat=1,29; Prob* $\dfrac{T_{indirect}}{Y}$ *= 0.047;* <br><br> *Prob* $\dfrac{T_{indirect}}{Y}$ *(-1) = 0.33;* <br><br> *Prob* $\dfrac{T_{indirect}}{Y}$ *(-2)= 0.014; Prob(F-statistic)= 0.000051* |

tion activities is an additional benefit of society, which can either be enhanced or limited as a result of some tax burden. When tax burden creates distortions in the choice of economic entities and accordingly forms tax incidence, innovation activities is limited, and vice versa. 2. Analysis of actual data on EU countries shows reason to justify the fact that, given the effective organization of tax burden, there may be a direct relationship between it (burden) and innovation activities. 3. Analysis of Ukrainian data confirms the absence of the relationship between tax burden and innovation activities. Therefore, the reform of the tax system towards fostering innovation activities is of current interest.

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Our findings in the area of the relationship between indicators of tax burden and innovation activities in Ukraine give some grounds to draw the following conclusions:
• this relationship is unlikely to exist or, if it exists, is insignificant;
• under condition that such a relationship exists, it is inverse, i.e. an increase in the tax burden limits the volume of innovation activities.

Comparison of the conclusions drawn from the calculations for EU and Ukraine forms the basis to answer the question whether there are any differences in the relationship between tax burden and innovation activities in countries with different levels of development. Such differences certainly exist regarding both the essentiality and the nature of the relationship.

The answer to the last question from the set formed at the beginning of this article (in what way can a government use the information about the relationship between tax burden and innovation activities to make management decisions) on Ukraine can be the following. If the conclusion of the absence of relationship is reasonable, the changes in the organization of the tax system should be directed to implement this relationship – creating a favourable tax climate specifically for innovators. Moreover, in order to monitor the actual state of affairs in the sphere of innovation activities it is advisable to use the same tools that other countries do. In particular, it would be effective to determine the index of innovation activities for the Ukrainian economy.

### Conclusions

1. Relationship between tax burden and innovation activities can be explained from the standpoint of the approach «losses – benefits». In terms of the «losses – benefits» approach, innova-

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# ФІСКАЛЬНІ ЕФЕКТИ СТРУКТУРНИХ ЗРУШЕНЬ У ПОДАТКОВІЙ СИСТЕМІ УКРАЇНИ

**Анотація.** *Оцінено обсяг податкових надходжень, на який можуть збільшитися доходи бюджету за умови структурних зрушень у бік оподаткування майна та процентних доходів від депозитних рахунків у банках за незмінного рівня загального податкового навантаження. Обґрунтовано можливість зменшення загального податкового навантаження без ризику бюджетних втрат. Запропоновано альтернативну структуру податкових надходжень у Зведеному бюджеті України.*
**Ключові слова:** *податки, податкова система, податкове навантаження, податок на майно, податок на процентні доходи за депозитами, структурні зрушення.*

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**ФИСКАЛЬНЫЕ ЭФФЕКТЫ СТРУКТУРНЫХ СДВИГОВ В НАЛОГОВОЙ СИСТЕМЕ УКРАИНЫ**

**Аннотация.** Оценен объем налоговых поступлений, на который могут увеличиться доходы бюджета при условии структурных сдвигов в сторону налогообложения имущества и процентных доходов от депозитных вкладов в банках при неизменном уровне общей налоговой нагрузки. Обоснована возможность уменьшения общей налоговой нагрузки без риска бюджетных потерь. Предложена альтернативная структура налоговых поступлений в консолидированном бюджете Украины.
**Ключевые слова:** налоги, налоговая система, налоговая нагрузка, налог на имущество, налог на процентные доходы по депозитам, структурные сдвиги.

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**FISCAL EFFECTS OF STRUCTURAL CHANGES IN THE TAX SYSTEM OF UKRAINE**

**Abstract.** The main part of the tax system in Ukraine make the taxes, the payment of which can be easily avoided. It complicates the management of them and doesn't give a possibility to fully realize the tax system potential. That's why the structural changes