

The taxation of human capital in heterogeneous households for the extended
euro area

SUMMARY OF THE DOCTORAL THESIS

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Abstract

The verification of thesis provides estimates for labor, capital and consumption tax Laffer curves based on the neoclassical, education based semi-endogenous (SE) and exogenous (E) growth models for closed economy, calibrated for the euro area, Poland and Hungary. The study investigates the Laffer curves, and the consequences of switching tax rates towards their peak. The basic model with the most variables on their balanced growth path (BGP) is extended by the no-BGP and BGP with heterogeneous households' versions. These extension prove to be more sensitive for the permanent changes in tax rates. Shifting tax rates to the top of the no-BGP model hampers the key economic aggregates significantly, with a modest increase in tax revenues.

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1. The thesis

In spite of several decades of the research, the neoclassical economics couldn't reach a consensus with regard to the impact of taxes on the economic growth. Generally, there are two opposite views for this issue: the first one suggests that the structure and the tax rates have no impact on the economic growth and the efforts should be undertaken to lower the tax rates, since it hampers growth by creating distortions - such an approach is called the static one. The second group of economists supports the view that the tax rates, a structure of the taxation system and e.g. the heterogeneity of the taxpayers matters significantly for the economic growth. The second approach is called the dynamic one. The notions of this proposition are very close in substance to the dynamic scoring, i.e. dynamic quantitative consequences after a change in fiscal policy. The advocates of the dynamic approach pursue, in general, to lower the tax rates, which may intensify the key economic factors and increase the product, which in some degree self-finances the lowered taxes by a higher tax base. Although, the dynamic concept sounds promising, but its practical quantification poses some serious problems, which seem to diminish its popularity among the researchers.

The study encompasses a wide range of subjects, and its main aim is to expand the existing general equilibrium modeling by a more precise calibration and verify if it matters. The key doctoral thesis are:

- **T1:** Switching from the basic model with the balanced growth path (BGP) for most variables to an alternative no-BGP model or to the BGP model with the heterogeneous households has significant consequences for the maximum achievable tax revenues, measured by the positioning of the top of the Laffer curve.
- **T2:** Shifting of the tax rates towards the maximum point of the Laffer curve (by increasing or decreasing them) for the direct and indirect taxation in the model with the representative agents and dynamically computed new steady states for the key economic variables, corrects these aggregates significantly.

In extension to the basic thesis, the two ancillary hypothesis are formulated:

- **H1:** The internal rate of return from investment in higher education and lifelong learning differs between the analyzed countries (the euro area extended by Hungary and Poland), and shifting of the tax rates towards the Laffer curve peak significantly frees or tightens the human capital taxation, built by an education in the particular countries.
- **H2:** A unification of the labor taxation progressivity among the considered countries may significantly change the life-cycle profiles of taxation and, at the same, modify the structure and a sum of tax revenues.

The thesis seem relevant, while the existing literature suggest that, depending on the applied modeling framework (semi-endogenous or exogenous growth model), the side and distance from

the Laffer curve peak differs substantially. From the practical point of view the Laffer curve may serve in the public debate as an argument to increase the fiscal burden. Therefore, the study adds a broader quantitative consequences for the key economic aggregates and factors. Finally, the list of investigated countries is quite substantial and aims to show the similarities and differences between the available EU economies in many aspects, observed from a perspective of the distortionary taxation. To this end, an issue of potential integration of the EU fiscal systems is tackled.

To verify the thesis, the neoclassical growth model for small closed economy is hired, where government imposes varying tax rates on labor, capital and consumption, to finance lump sum transfers, public consumption and debt servicing costs. The model is investigated for the representative agent version and the overlapping generation version, where the tax rates and physical and human capital vary over the life cycle. The government debt and its servicing costs are fixed on their long-term balanced growth path (BGP). The objective functions are consistent with the long-term growth, while the government result needs to be balanced. Three fiscal channels are investigated: 1) labor tax, 2) capital tax and 3) consumption tax - all three with the balancing role of the government transfers. The semi-endogenous growth factor for human capital relies on the estimated internal rate of return on investment in higher education and lifelong learning. The additionally estimated effective tax rates are replaced by the alternative ones that match data more accurately. The study repeats the calculations of the Laffer curves and respective impact on the key economic aggregates for the extended euro area by Poland and Hungary. Their selection was limited by the availability of the wealth survey database (so called HFCS) provided for the individual request by the European Central Bank, which is used for benchmark heterogeneous households model.

Basically, the proof of the thesis relies on three sets of comparable models, which differ in their internal construction. The basic model relies heavily on the concept of Uhlig et al (2011) model for the representative agent (RA/BGP further). It's simplified and reduced by trade balance and government investment, and if loaded with the same input data, gives nearly the same results as the original model. The next RA/no-BGP model returns to the representative agent approach but differs from the basic model in terms of the approach to the balanced growth path (BGP). In this model, the proof for difference relies on a dynamic steady state computed for each point of the Laffer curve, so with less strict approach to the BGP. The heterogeneous agent model aims to show the statistically significant improvement of the results if the representative agents are replaced by the bunch of single age cohorts endowed with a different sets of 1) labor supply, 2) human capital and 3) physical capital. The current section shows their internal construction, pointing out the differences that are relevant for the thesis.

The null hypothesis is confirmed if the numerical results between the models show economically meaningful differences between these three. It may mean that it makes sense to complicate the existing approach by adding the heterogeneous agents or remove a strict assumption on the BGP to verify e.g. the consequences of some tax reforms. The "percentage" of the rejection or approval of the thesis and hypothesis may depend on the sum of the partial conclusions.

2. Literature overview

On the background of the existing literature in terms of the distortionary taxation for the economic growth, the study tries to enrich the education based semi-endogenous neoclassical growth modeling in several directions. Firstly, in the representative agent framework, the approach by Rebelo (1991) and King et al. (1999), applied by Uhlig et al. (2011) is here expanded by the removed BGP approach for nearly all variables. Instead, only several variables and all parameters are fixed on their sort of BGP to investigate if the dynamically computed physical capital, consumption, wages or product influence significantly the shape of the Laffer curves. Secondly, for the heterogeneous agent's approach, the study takes a step forward from Uhlig et al. (2012) in terms of the life-cycle profile of labor hours, taxes and capital, to verify if such an approach makes a difference. It varies from , Krueger et al. (2015), because it doesn't show the changed behavior that stems from the microsimulation in order to isolate the pure or static effect of changed tax rates and progressivity on the shape of the Laffer curves. Finally, the study gathers the euro area countries (plus Poland and Hungary) for the first time, so it enriches findings of Uhlig et al. (2012) and Guvenen et al (2008) to investigate the variety of taxation patterns and the directions of the economic distortion if taxes are unified. The intermediary data refreshment extends the findings of Boerini et al. (2011), De La Fuente et al. (2009), Florczak et al. (2016), Paturot (2012) or Bukowski et al (2005).

3. The intermediary data summary

While the study gathers a wide range of subjects, the intermediary analysis are required to create the parameters that are outdated or not present in the existing data basis and literature. Starting from the first issue, the profiles of gross income and wealth are very different across the extended euro area, provided that the HFCS data are representative. The peaks vary for age, the cumulation of wealth is in some countries smaller than income, and higher in others. The tax progressivity functions show a wide variety of scales and, in fact, average effective rates for employees' labor tax. It seems very hard to combine a common tax union based on equalized rules to be equally distortionary for e.g. Belgium and Malta. The examination of gross/net salary and taxation profiles provides another surprising observation: in most countries in the early period of labor career, a relatively low taxation is offered. In non-euro area country i.e. Poland a person starting to work is hit by the flat tax. The Kakwani index brings some surprises for a single number to summarize the graphs with gross/net income profiles. The high index occurs for LU or IE, and the low occurs for BE or AT, although, these countries are high in tax progressivity list. A smaller correlation between the tax progressivity and wage dispersion in the CEE countries, where the flat taxation dominates, as compared to the WE countries with their higher progressivity, should be not a surprise. The question may be asked then, if there's other way that increasing tax progressivity in the CEE countries? The effective tax rates are high in the developed WE countries and lower in the CEE countries, and some euro area peripheries, especially for the capital taxes. For labor taxes the effective tax rates range between 53% in Austria and 27% in Ireland, while the capital tax rates vary between 39% in Belgium to 9% in Estonia. The smallest range of tax rates occurs for consumption tax rates and varies between 25% in Luxembourg and Hungary to 14% in

several countries¹ As for the other macroeconomic variables, the differences across the euro area are significant too, especially for the production function inputs: (setting Greek data aside) Finland has nearly 3 times more capital than Latvia, while Germans work by 1/3 less than Poles. It may seem then, that a unification of the tax systems could be an evolutionary process, where the growing product is substantially linked with the higher taxation of labor and capital.

The semi-endogenous growth model intermediary data brings fairly comparable figures to these from the literature for both internal rate of return (IRR) and the lifelong learning. However, as compared to the proxies applied in Uhlig et al. (2011, 2012) the actually calculated estimates are more than halved. The most obvious consequence will be that the excessive taxation would probably distort the investment in education faster, just as in case of low rate of return on physical capital.

4. The representative agent model results with the BGP

4.1. The labor tax Laffer curve

As in Uhlig et al. (2011) the SE model shows that the taxation of the human capital is more distortionary than the pure exogenous growth model. Consequently, the SE shows the top for a lower rates, and some countries are on the wrong side of the peak. In comparison with the country specific results of Uhlig et al. (2011), the top revenues may be theoretically achieved for France, with the lowest for Cyprus² for both SE and Ex models. With regard to the distance between minimum and maximum rate of the top, the minimum in the Ex model occurs for Poland and the maximum for Belgium. These narrow brackets (POL with 68% and BEL 78%) set a theoretical margins for the labor tax revenue maximization in the euro area, provided that the balanced growth path for the key variables remains unchanged. A comparable setting for the SE model gives the minimum peak for Slovakia (45%) and the maximum rate for the top for Latvia (73%).

The strength of the overall taxation extended on the human capital can be spotted in the SE model, where many countries are on the wrong side of the top and close to it. The order of countries in reference to the maximum achievable level of tax revenues is not far from the order of the overall taxation burden, with high ranks for Belgium and Austria. The exception of Ireland, which ranks low in the overall taxation burden may stem from a high level of the IRR, which, if taxed excessively, moves the top of the curve to lower rates, which may also explain the high position of Poland or Hungary, and low position of Luxembourg. The minimum labor tax rate to reach the peak occurs in the SE model for Belgium (22%) and the maximum for Estonia (54%). A comparable range for the Ex model is achieved for Slovakia (52%) and Portugal (73%). The divergence of the last mentioned tax rate span barely overlaps, which seems a hard task to solve in the direct policy formulation.

To summarize the results of this subsection, firstly, the range of the effective labor tax rates, if suddenly unified across the euro area plus PL and HU, would mean much higher increase in the CEE countries tax rates. This could deteriorate the competitiveness of these countries with possibly

¹The study skips an issue of the tax system efficiency to minimize the tax evasion and fraud, but it may be of some relevance to compare the effective tax rates with their nominal counterparts and achievable revenues.

²Cyprus data is incomplete, which pose a question mark on the results.

higher tax revenues. Secondly, the order of the countries for the maximum achievable labor tax revenues reflects well their order for the effective rates. At last, but not least, the taxation of human capital influences the horizontal, but barely the vertical alignment of the labor tax Laffer curves.

4.2. The capital tax Laffer curve

Not surprisingly, the range of the effective capital tax rates across the euro area is wide, starting from 9% in Estonia and ends with 39% for Belgium. A bit surprisingly, the capital tax Laffer curve for the capital tax revenues perspective shows a strong negative correlation with the effective capital tax rate order with some exceptions. The highest achievable capital tax revenues are envisaged then for Estonia, while the marginal tax revenues are the highest with the marginal increase of the tax rate by one percentage point. A very remote peak of the Laffer curve makes this graph rather barely applicable in a direct policy formulation. There are no differences between the SE and Ex models, which shows a very strong role of the physical capital and its rate of return in the neoclassical growth model.

The capital tax Laffer curve for all tax revenues orders countries closely between the overall taxation burden list of overall taxation burden in considered countries and the capital taxation order. Both charts suggest that it stays nearly indifferent for the changes of the tax rates, however, the SE model shows the maximum point for 0% rate for some countries.

It seems hard to discuss the unification of the capital tax rates in the euro area using this class of models, while a nature and size of the financial markets may have historically forced the high capital taxation of the speculative capital.

4.3. The consumption tax Laffer curve

The consumption tax ranges in the available dataset considerably, i.e. from 14% in Italy and Spain up to 25% in Hungary. Interestingly, the first two countries rank high in the list of input data aggregates for the private consumption level. The maximum point for the consumption tax is beyond the 100% rate, which stems from the construction of the utility function, where the households must consume to maximize the utility function. The SE model mimics the order and nearly repeats the shape of the Ex model. The countries with a high consumption contribution in product take the high ranks in the potentially achievable consumption revenue levels.

The results of the consumption Laffer curve for the consumption taxes shows quite a narrow spread of the maximum achievable consumption tax revenues across the extended euro area. The order of countries, as in two previous analyzed types of taxes, is close to the list of the overall taxation order in considered countries.

5. BGP vs. no-BGP

5.1. The labor tax

The current section tries, as explicitly as possible, to verify the thesis of this study in terms of differences between the scenarios, in which nearly all variables are fixed on their BGP and where

only few key variables as set on their BGP.

Interestingly, the top points for both models are the same (vertically), which should not surprise, while a very close set of equations should give a comparable maximum point. The no-BGP model gives somehow higher achievable taxes, especially for the exogenous growth model. What may serve as a value added is another feature that can be observed, i.e. the arms of the no-BGP model decrease faster, i.e. for lower rates. It seems to be a consequence of dynamically computed capital and labor, which seem more sensitive to the distortionary taxation. With this respect, the no-BGP RA model is then more sensitive for the fiscal policy in the neoclassical growth framework.

The labor Laffer curve for the entire tax basis also reacts faster for the increasing tax rates, but this effect is hampered by the other tax rates that stay fixed. In both types of curves the order of countries is very close to the BGP version.

5.2. The capital tax

In case of capital tax the no-BGP model shows much narrower span between minimum and maximum achievable tax revenues between countries. The no-BGP model reacts comparably for high and low capital taxation, which trims significantly a promise for high tax revenues for e.g. Estonia. The maximum point is remote as in BGP version, which makes this type of model not very useful for a direct policy application.

Contrarily to the BGP version, the no-BGP model suggests an increase in overall tax revenue with the increased capital tax rates. However, in this scenario, the labor supply increases significantly to overcome the shrinking incomes from the capital, in order to sustain the consumption / utility of the households. There is a difference between models, which positively verifies the thesis, however, the conclusions may suggest that the capital taxation may give a momentum to the tax revenues. To see if there is a free lunch, this case will be checked later for its impact on the key economic variables, since the capital taxation in the neoclassical growth models is usually very costly for the product etc. This is one of the reasons why the no-BGP model was added in this study, i.e. to be able to verify the costs (or benefits) of shifting the tax rates to the top of the Laffer curves, which would give the same aggregates for the BGP model.

5.3. The consumption tax

Similarly to the capital tax Laffer curve, the no-BGP ribbon is narrower than the BGP one. The dynamically solved consecutive equilibrium give a much less optimistic tax revenues also for the consumption taxation. However, there's also no maximum point up to 100% rates, but the euro area countries seem more homogeneous in terms of their reactions.

The full tax basis shows nearly no difference between consumption tax Laffer curve for the entire tax basis in the exogenous growth model, but much higher potential revenues in the semi-endogenous growth model (left above).

To conclude this section and to verify the thesis: there are significant differences between the BGP and no-BGP models mainly in terms of the sensitivity of the latter for the increasing tax rates. This type of model seems handy to see the potential of the economy in response to a distortionary

taxation. The most sensitive are the labor taxes, with the consumption taxes barely sensitive. The second models may be then handy to verify the elasticities of the key economic aggregates for the excessive taxation.

6. RA BGP vs. heterogeneous BGP

This section attempts to verify the thesis on RA versus heterogeneous households income and wealth. The maximum point of the heterogeneous labor Laffer curve for labor taxes occurs for lower rates than the in the basic (RA) model. The reasons may stem from the much faster reduction of the disposable income in the households with higher income, in response to the higher tax rates. This seems to be also a reasons that the SE model shows a very similar fast shrinking labor tax revenues than the basic RA model, which makes it comparable in shape to the no-BGP model. The exogenous growth model shows a smaller range of curves with a comparable slopes. The capital and consumption tax heterogeneous agent Laffer curves show a less relevant differences, therefore, they're skipped in this summary.

7. Shifting of the tax rates towards the peaks

This section provides the summary of consequences of the hypothetical scenario, where the tax rates are shifted towards the peak of the Laffer curves the results for a combined for all countries. It would be naive to perform such nuclear scenario in reality, but also it doesn't make sense to believe in the exact results. The model reflects the key features of the reality, but the reality is much more complex. Nevertheless, the current section may help to somehow approach the direction, in which the unification of the fiscal systems may go if so decided. Logically, the results take into consideration only the no-BGP RA model, which allows to investigate the corrected aggregates due to changes in tax rates.

As stipulated in the literature review, the dynamic scoring exercise by e.g. Mankiw et al. (2006) suggests that a reduction of the tax burden may generate enough momentum in the economy to self-finance the tax revenues reduced by the decreased initial tax rates. The current study doesn't operate on such tools, but due to a construction of the no-BGP model allows to control the changes in equilibrium values of many other key economic variables. If there are no free lunches, then a reduction in the tax burden for a specific fiscal channel should show the particular adjustments for many other key variables. The unification of the effective tax rates in order to achieve the "more consistent" tax rate span in the euro area than currently, would mean a reduction of the rates for some Western European countries, and an increase of such rates for some Central-Eastern European countries. The thesis of the study presumes a verification of such an approach. The shapes of the curves make such task much easier for the hump shaped labor Laffer curves (both, the labor tax and the entire tax revenues versions), a bit more difficult for the capital tax, and hardly believable for the consumption tax rates.

All countries are actually on the correct side left hand side of the Laffer curve for the exogenous growth model, which, in spite of an update of the data to 2014, doesn't bring the new conclusions

as compared to Uhlig et al. (2011). In order to leave the overall tax revenues unchanged, the fiscal channels are exchanged within each considered country: usually a reduced labor tax rate or abolished capital tax is replaced by an increased consumption tax rate. A switch between scenarios is performed for these countries firstly, which are on the right hand side of the Laffer curve. Additionally, also for these countries, which are on the left hand side of the labor or the capital curve, but due to a high contribution of the consumption in the product, are a promising candidates for high additional e.g. consumption tax revenues collected via such less distortionary channel. There are, however, cases, where the model suggests that an excessive taxation burden is so high, that a reduction of taxes would bring the extra revenues that fully self-finance the decreased rates. In these rare cases, the consumption tax is not increased. In cases, where the tax scale seems optimal from the point of view of the Laffer curve, the consequences are left blank.

In most cases the labor taxes are significantly reduced (mainly in the developed economies from the WE), the capital taxes are abolished or reduced and these are replaced by the consumption taxes. Consequently, the tax revenues in these countries would decrease as compared to their relation to the growth of product, so the self-financing would be incomplete. But, they're additionally financed by a less distortionary consumption taxation, with a reduced differences in the effective taxation across the euro area. The range of the effective labor taxation in the extended euro area span between 33 and 38%, from an initial 29 to 53%. Furthermore, the capital taxation range would be lowered to 9 - 20%, from an initial 9 to 39%. Finally, the consumption taxation would increase to 18 - 29% range from an initial 14 - 25%. The corrections are neither complete nor, honestly speaking, fully consequent. They're not complete, since there are countries, where the distortionary capital taxation existed and was left unchanged. Foremost, the capital taxation in the no-BGP model doesn't seem *that* much distortionary, as in the considered BGP models. They're not consequent, while the no-BGP model suggests that a reduction of the capital tax would mean a reduction in the overall tax revenues in all cases, for details see the slope of the SE capital taxation for the entire tax base. However, the reduction in tax rates means a particularly significant and positive influence on the investment and physical capital level, that allows to spur the economic performance. Such an approach, that stems from a very literal application of the Laffer curves in this study, would have some (potential) consequences listed below.

- The shifted labor and consumption tax rates have an equal impact on the the product Y , private consumption C , debt B , capital K , investment I and government consumption G . The less significant impact can be spotted for labor L , human capital H and government transfers T . The wages stay unaffected.
- The shifted (reduced) capital tax rates have more varying impact, mostly significant for the capital and investment, less valid for labor and human capital, varying for private consumption, government transfers, government consumption, debt and wages.
- With one type of taxes reduced, the other bring the additional resources, which in most cases, improve the overall tax revenues, but the self-financing is never complete (the tax revenues decrease or increase slightly, bet never as much as the product).

- The countries with high return from the investment in education outperform in gains those with lower return on human capital, e.g. Belgium is better-off than Luxembourg.
- A reduction or abolition of the capital tax neglects in this class of model the existence of the capital market that can be significant in size and unequal in composition and stability. The fact of existence of the distortionary capital taxation may then refer to the historical correction of the highly volatile financial market.
- The expected power of the additional resources liberated with the reduced tax rates, can be easily misinterpreted as the firm change, will be prone to the volatility of the business cycle. Therefore, the reduced tax rates may result in a reduced tax revenues if the business cycle is about to go down.
- The replacement of the more distortionary taxation (reduced labor and capital tax rates) by the less distortionary taxation (consumption tax) may tend to difficulties in the exact budget planning due to the well known aspects of the tax evasion and uncertainties about the business cycle, which may lower the expected revenues.
- A point above may then destabilize the vital elements of the fixed budget expenditures, e.g. social and health care spending or investment plans.
- An increase in the consumption tax rates may, however, change the relationships between the key economic aggregates towards a smaller contribution of the consumption, some of which were very negatively affected by the recent financial crisis.
- The reduced effective labor tax rates may be replaced by a more progressive taxation to keep sustain the revenue levels, or keep the inequality ratios low.

7.1. Results for a changed labor tax progressivity

The current subsection attempts to show the consequences of switching between the labor tax progressivity regimes already computed for the available countries. It aims then to reply to hypothesis 2 of the study, which seeks to answer if changes in the progressivity indeed influences the life-cycle path of income and the revenue aggregates.

One of the most flat tax rates across the life-cycle can be observed in Poland. It seems a good candidate to exercise the switching between the tax progressivity scales. The Kakwani index in Poland suggests a low inequality in distribution of income, while the profile of income increase intensively up to age of 40, in line with the financial wealth, and starts decreasing from age of 40 as in e.g. Portugal. This shape of the profile is characteristic also for the many other CEE countries. The variance of income, however grows after age of 40, as if those who succeed at the labor market took over a part of those who's salaries / labor hours shrink. While the inequality measures are lower than in other countries, the progressivity seems not necessary, but while the precautionary measures can influence the inequality that may occur in the future, such an option is investigated below. Basically, an extreme scenario will be applied to check the exaggerated consequences, and the

progressivity tax of Slovenia will be applied. The aim is to check if indeed the low income earners would get an effective relief, and if the richer households will carry this burden.

Although, the switch to a progressive labor tax doesn't look significantly, a usual disclaimer may be reminded: the labor-active-life-cycle in this study relies on the average profiles for each cohort that do not reflect the density of income concentration within each cohort. The results suggests a slight increase in the net income for households that earn the lowest salaries, but may bring some significant profits if the young and relatively rich cohorts were affected.

8. Verification of the thesis

The verification of the **Thesis 1** in light of the achieved results: the thesis can be fully verified for the no-BGP model. The results differ in terms of conclusions for the macroeconomic policy, while the labor tax curve and capital tax curve are much more sensitive for the distortionary taxation. Surprisingly, the capital taxation is less distortionary in the no-BGP full tax version, where an increase in the capital tax rates would mean an increase in the overall tax revenues, which makes an issue of the distortionary capital taxation a bit nuanced.

To verify the **Thesis 2** the rates were moved to or towards the peak of the Laffer curves in two directions: they were lowered in the most WE countries and increased in some CEE countries in order to achieve smaller span of distortionary taxation in the extended euro area. Due to the shape of the Laffer curves such manipulation was much easier for the labor curve than for capital curve. The increased rates for the consumption Laffer curve that has no maximum point in up to 100% tax rates was performed "reasonably". Although, it seems easy in the theory, but hardly imaginable in practice: the taxation in particular countries had a long tradition and was created to stabilize this country public transfers and consumption. A mass reduction could destabilize the fixed budget payments of pensions, undermine the public investment and threaten debt servicing costs. An adequate increase in e.g. labor taxation in some CEE countries, which have smaller absolute product, would deteriorate these developing economies terms of trade and hamper their economic potential. The unified fiscal area could produce enough economic momentum to overcome the reduced tax rates and bring extra resources in the common budget that could be divided among all countries. Such an optimization goes beyond this simple study, but may be further investigated. To summarize: the thesis may be assumed as positively verified, while the changes are significant from the economically realistic point of view.

The verification of **Hypothesis 1** may rely. Apparently, the rates of return on investment in higher education and the lifelong learning differ significantly between the extended euro area countries, also if the literature findings are additionally taken in to account. The second part of the hypothesis 2 refers to the possible significant influence on the human capital of the tax rates moved towards the peak of the Laffer curve. In fact, the investigated cases of tax rates shifted towards the top of the Laffer curve relied on the SE model. The human capital is among the variables that are affected by the changes. The human capital changes in line with the labor supply, and its changes are significant: in most cases where the distortionary taxation, either labor, capital or consumption, is reduced (increased) the human capital improves significantly, and deteriorates less significantly. A positive shift in the human capital may be observed in labor tax rate reductions. A slight deterioration can

be spotted in cases of the increased consumption tax, which is the least distortionary fiscal channel. Consequently, the hypothesis 1 is confirmed.

Finally, the **Hypothesis 2** refers to the differences between the hypothetical scenarios, where the progressivity of the labor tax are changed in particular countries. The difference can be easily spotted for the life cycle net income patterns, which confirms the first part of the hypothesis. But for the second part, i.e. related to the aggregates only one (for Poland with the Slovenian progressivity) out of three abovementioned cases the revenues differ significantly from the default progressivity schedule. To this end, the strength of the positive verification of the hypothesis is smaller than in the previous cases. Certainly, it's possible to create an imaginary progressivity rate enough different from the default settings to change the other two cases, and any nearly any other, but it's beyond the scope of this study to optimize the tax functions that far.

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