Testing of Koch method applied for evaluation of ornamental trees in the Czech Republic

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ABSTRACT: Koch method of ornamental trees evaluation is based on interest paid on costs invested in tree-growing up to their maturity stage minus deductions for age, defects and damage. The aim of this paper is to apply the above mentioned method in the economic conditions of the Czech Republic. The paper presents essential economic data generated in accordance with the technological model of tree growing at a permanent site. We also describe the mechanism of the so-called base tree price calculation as a basis for the subtraction of deductions derived from its current condition. The calculated base tree prices are illustratively compared to prices based on the to-date applied calculating techniques and the relevant regulation. We also refer to the method of base price adjustment based on the criterion of landscape tree value. The mechanism of price calculation applied for Koch method testing included two modifications. The first relates to due consideration of growth qualities when calculating development care costs; the other introduces landscaping value indicator as the only base price adjustment to achieve the resulting price, corresponding with the current tree condition.

Keywords: Koch method; woody species evaluation; ornamental trees; tree-growing costs; development care; base price; resulting price; landscaping value

Koch method (Koch 1971; Schulz et al. 2002; Breloer 2007a) for calculation of real value (price) of ornamental trees ranks in Germany among the universally recognized and so far utilized methods of woody species evaluations in cases of destruction, damage or expropriation. The method is, in principle, based on interest paid on costs invested in woody plants growing up to their maturity stage minus deductions for age, defects and damage incurred prior to the determining event. Instructions for practical application of the methods are to be found in the relevant manuals, elucidating working procedures, containing indicative economic data as well as calculation examples, in particular related to trees (Hötzel, Hund 2001; Schulz et al. 2002). The methodology is discussed by experts on annual basis, let alone some well-known court verdicts (Breloer 2007a,b). In the CR, the method has not been tested so far. Its principles are, however, theoretically accepted by, for instance, Pejchal and Šimek (2003) while its benefits are doubted by Pilař (2003). Both the ambivalent viewing of Koch method and the fact that the current Czech woody species evaluation manuals (Grulich et al. 1992; Kolařík et al. 2005) and the Decree of the Ministry of Finance No. 3/2008 Coll. are not sufficiently transparent with regard to prices were instrumental in adopting the decision to test the method (Bulíř 2007). Thus, the aim of our work has been to apply Koch method to determining and adjusting base ornamental tree prices in our current economic conditions and to compare them with prices referred to in the current Czech manuals.

MATERIAL AND METHODS

Base tree prices were set using the latest published version of Koch method (Hötzel, Hund 2001).

Both material and labor costs were calculated based on a technological model of permanent site tree-growing, split into the following stages:

- young plant planting, including its purchase and shipping,
- subsequent three-year development care (site establishment period),
- development care continuation for another 10–40 years (up to the stage of full maturity).

Young tree plant price of each species (cultivar) was calculated as a mean value derived from the

prices of identically sized young plants sold by five most prominent Czech producers, including 5% value added tax (VAT). Shipping costs of transportation from producer to planting sites were calculated using the flat rate of 18% of the young plant price. All labor operations performed during individual stages of the technological model were assessed in line with the Catalogue of Building Operations Descriptions & Indicative Prices – 823-1 Land Areas & Development (2006). Prices of identical labor operations in various terrains (plane, slope 1:5–1:2, slope steeper than 1:2), and prices of operations incorporating alternatives (e.g., hole-digging without soil replacement, or with 50% or 100% replacement) listed in the said Catalogue were averaged. Prices of supplementary material (compost, humus soil, fertilizers, stakes, water, mulch and others) were taken over from current price lists of major producers and distributors (including VAT), being averaged as above. Overall development care costs were recalculated to reflect average annual costs. Interest on costs was fixed at 7% interest rate, based on banking rates for mid-term and long-term loans, mortgages, bonds, deposits and other products present on the market for the last 40 years (Rosochatecká, Tomšík 2007). Growth failure rate in the course of establishment stage was set at 10%.

RESULTS AND DISCUSSION

The first cost input in base tree price calculation is represented by the wholesale price of a young plant of a specific cultivar in the shape of a tall-trunk standard and the selected stem circumference size. It is necessary that the young plant size should be adequate to the envisaged function of the tree at the given site (object of greenery), which may either increase or decrease its value. Initial costs also include transportation of young plants from nurseries to the planting site, including planting itself plus necessary support materials (compost, fertilizers, stakes, etc.).

Table 1 lists examples of young plant prices for certain woody taxa, including transportation. The table gives the prices of tree sizes most often planted in parks, gardens and housing estates greenery. At the same time, the data given in the table reflect actual supply on our young tree nursery market. Unlike in Germany, larger young plant sizes of deciduous trees are, as a rule, not available in our ornamental tree nurseries. Thus, calculations are determined by these facts. However, in exceptional cases or where prominent landmarks are concerned (trees in the parterres of historical parks, representative buildings, memorials, central squares, etc.) we do allow for the possibility of calculating base tree prices individually bearing in mind the prices of bigger young plants which may be imported from abroad.

The table also demonstrates apparent price differences among individual tree taxa. The differences point out the fact that the objectively calculated base prices of individual taxa cannot be the same; on the contrary, they have to differ.

In our instance, the issue of shipping costs was not addressed along the lines of real costs but as an 18% flat rate of the young plant price. Our aim was

Table 1. Dendrological features of selected taxa and average prices (CZK) of young plants – tall-trunk trees with rootball, including 5% VAT, 18% shipping, grown in the Czech Republic in 2007

Tree name	Characteristics		Size – stem circumference (cm)			
	crown	growth	10–12	12–14	14–16	16–18
Acer platanoides Globosum	SC	MG	1,097	2,000	2,679	3,375
Acer pseudoplatanus	LC	MG	549	1,015	1,328	1,829
Alnus glutinosa	MC	FG	679	1,050	1,493	1,864
Corylus colurna	MC	MG	637	1,174	1,628	2,059
Platanus × *acerifolia*	LC	MG	962	1,192	1,646	2,159
Prunus serrulata Kanzan	MC	MG	838	1,605	1,947	2,667
Quercus robur	LC	SG	1,239	1,782	2,083	2,626
Tilia cordata	LC	MG	867	1,239	1,634	2,100

LC – large crown, MC – medium crown, SC – small crown, FG – fast growth, MG – medium growth, SG – slow growth

Table 2. Average prices of labor operations and essential materials for permanent tree planting (parks, gardens, housing estate greenery) in 2007

Labor operations and material specifications		Young plants – stem circumference (cm)			
		10–12		12–14 to 16–18	
		bulk/quantity	CZK	bulk/quantity	CZK
1	Hole-digging	0.125 m^3	157.56	0.4 m^3	595.67
2	Planting + compost + soil 1:1	0.06 m^3	72.38	0.2 m^3	162.63
3	Fertilization + NPK + Silvamix	0.1 kg	5.46	0.2 kg	10.92
4	Anchoring + stakes + cross-bars + ties	1, 0, 1 piece	72.00	3, 3, 3 piece	395.50
5	Stem wrapping + hemp tape	0	0	4 m/15 cm	38.20
6	Mulching + bark mulch	0.05 m^3	55.33	0.07 m^3	78.25
7	Watering + water	5 × 10 l	36.30	5 × 20 l	72.60
8	Tree maintenance	1×	56.25	1×	56.25
9	Moving of materials	0.2 t	126.00	0.55 t	346.50
10	Subtotal		581.28		1,756.52
11	VAT	19%	110.44	19%	333.74
12	Total		691.72		2,090.26

to develop indicative base prices, not to calculate base tree prices for a known site by a specific day. The used rate is based on former rules applicable to budgeting of landscaping works, i.e., it has its roots in the period when the majority of today's mature trees had been planted. When assessing a specific case, it is obviously more accurate to make the calculation based on actual shipping costs. Fixing of flat transportation rates still remains an open issue and will be subject to further fine-tuning.

Table 2 presents a model budget and a cost balance related to young tree planting at a permanent site in parks, gardens, and housing estates. The budget includes all essential labor and technological operations and materials associated with planting under standard conditions. Soil preparation operations are however excluded as they are, as a rule, not performed as part of complementary planting at the existing greenery sites. Here, tree planting begins with digging of the hole. In cases of newly

Table 3. Average price of yearly tree development care during the establishment period at permanent sites in 2007

Labor operations and specification of materials	Cumulative price (CZK)
Formative pruning 1×/year, watering, incl. water 5 × 30 l × 3 years, fertilization, including NPK + Silvamix 30 dkg × 3 years, planting basin weeding 2×/year × 3 years, removing of stem wrapper, visual tree checking, moving of materials, VAT 19%	511

Table 4. Average price related to the continuation of yearly development care from tree establishment to their maturity in 2007

Labor operations and specification of materials	Cumulative price (CZK)		
	small crown	medium-size crown	large crown
Maintenance pruning 1×/4–6 years, fertilization incl. NPK 1.5 kg in 3 years, visual tree control 1×/year, moving of materials, VAT 19%	268	512	689

established sites, as confirmed by our findings, site preparation does not represent any considerable cost-related sum.

Tables 3 and 4 present average annual development care costs for the period of tree establishment and further maturation. The third stage costs (Table 4) are, unlike in Koch method (Hötzel, Hund 2001), calculated for the total of three crown sizes. We have adopted this decision due to distinct differences in growth and the need of actual care, in particular with respect to trimming of diverse cultivars. Trimming of trees that naturally develop larger crowns is more demanding both in terms of time and finance in comparison with the trimming of small-crown species. Other labor operations as well as material consumption (fertilizers, etc.) associated with these trees also appear to be more expensive. The first modification of Koch method as applied in our economic setting concerns the differentiation of development care costs associated with tree crown sizes.

The actual calculations of costs related to individual growing stages presented in Tables 1–4 were taken as primary input data for base price calculations of a specific taxon. In addition, the calculation construction was complemented with flat rates for growth failure risk of 10%. This rate is slightly higher than the rate published in the Budgeting Catalogue; the reason is that it relates to the whole of the establishment period which spans longer than is considered ordinary. In accordance with both theoretical and practical experience, the envisaged establishment period for a newly planted tree at its permanent location was fixed for all sizes of young plants to last three years. The remaining time of development care – from establishment to full maturity – was addressed by using a differentiating approach based on the genetically determined growth speed and crown character of the individual taxa. The fastest-growing species, the species growing at mid-speed, and the slowest-growing species were assigned 10–15 years, 15–30 years and 30–40 years, respectively. The length of this stage was determined by applying information from dendrological publications as well as practical experiences. Data on the growth speed of individual taxa will be further specified.

Table 5 presents the mechanism of calculating a base tree price derived from various young plant sizes. The calculation formula includes compound interest tools; the applied 7% interest rate is a rate specially identified for this work (Rosochatecká,

Table 5. Example of base price calculation of small-leaved lime (*Tilia cordata*) using various young plant sizes with rootball, establishment period of 3 years, maturation period (development care) of 25 years, 10% risk, and 7% interest

Item calculation method		Tree price (CZK) using young plant (cm)			
		10–12	12–14	14–16	16–18
1	Young plant, shipping, planting, actual calculation	1,559	3,329	3,724	4,190
2	Yearly development care (YDC) in the period of establishment (PE); actual calculation	511	511	511	511
3	Interest on initial investment for PE; 7% from 1st line	109	233	261	293
4	YDC during PE incl. interest on investment; 2nd line + 3rd line	620	744	772	804
5	Development care costs during PE; 4th line × saver 7_3 (coefficient 3.2149)	1,994	2,392	2,481	2,586
6	Risk; 10% from 1st line + 5th line	355	572	621	678
7	Total establishment costs; lst line + 5th line + 6th line	3,908	6,293	6,826	7,454
8	Establishment costs expressed in future value after achieving full maturity; 7th line × interest coefficient 7_{25} (coefficient 5.4274)	21,212	34,155	37,046	40,455
9	YDC after PE; actual calculation	689	689	689	689
10	YDC costs after PE until full maturity; 9th line × saver 7_{25} (coefficient 63.2490)	43,579	43,579	43,579	43,579
11	Total costs = base price; 8th line + 10th line	64,791	77,734	80,625	84,034

Table 6. Base prices of various taxa of young plants with rootball, based on stem circumference sizes, including VAT (5%) and shipping (18%) in 2007

Woody plant	Characteristics		Base price (CZK) by size of stem circumference (cm)			
	crown	growth	10–12	12–14	14–16	16–18
Acer platanoides Globosum	SC	MG_{15}	18,373	26,927	29,450	32,038
Acer pseudoplatanus	LC	MG_{25}	62,461	76,094	78,381	82,049
Alnus glutinosa	MC	FG_{15}	22,947	29,527	31,172	32,554
Corylus colurna	MC	MG_{25}	51,913	66,064	69,387	72,537
Platanus × *acerifolia*	LC	MG_{25}	65,481	77,389	80,711	84,465
Prunus serrulata Kanzan	MC	MG_{15}	23,540	31,589	32,861	35,537
Quercus robur	LC	SG_{30}	98,648	118,556	121,643	127,211
Tilia cordata	LC	MG_{25}	64,791	77,734	80,625	84,034

LC – large crown, MC – medium crown, SC – small crown, FG – fast growth, MG – medium growth, SG – slow growth, index – estimated number of years needed to reach full maturity

Tomšík 2007). Its current level can be considered as an initial foundation for Koch method application in the Czech Republic as well as for discussions among relevant experts. This rate will be undoubtedly subject to change in relation to economic development of this country as was observed in Germany (e.g., Breloer 2007a).

Base tree prices are defined as total costs spent on woody plants growing up to the time of their complete maturity (see Table 5). The quoted base prices are maximum prices applying for optimally developed, sound and undamaged specimens in solitary position, aged 40–45 years and older in case of slowly growing trees or 20–25 years and older in case of fast growing trees. Obviously, base prices of younger specimens which have not yet reached the indicated age limits are lower. Table 6 gives base prices of other species differing from one another by crown size and growth speed in their maturation stage. Test calculations have indicated that, for the determination of objective prices, these factors are indispensable. The reason is that they are essential for determining annual development care costs and its overall duration, which is, in turn, reflected in the level of base prices. To modify Koch method in this particular aspect appears as duly beneficial.

Table 7. Comparison of maximum base tree prices (CZK) listed in Czech manuals & Decrees to those in Germany (€), interest 4%, risk 10% (Hötzel, Hund 2001)

Woody plant	Koch* CR (2007)	Grulich (1992)	Kolařík (2005)	Decree No. 3/2008 Coll.	Koch* Germany (2001)
	(CZK)				(€)
Acer platanoides Globosum	29,450	?	?	100,660	?
Acer pseudoplatanus	78,381	395,006	395,006	84,280	2,251
Alnus glutinosa	31,172	170,000	170,000	51,420	1,363
Corylus colurna	69,387	270,000	270,000	100,660	2,630
Platanus × *acerifolia*	80,711	395,006	395,006	100,660	2,202
Prunus serrulata Kanzan	32,861	?	?	100,660	1,486
Quercus robur	121,643	395,006	395,006	100,660	3,171
Tilia cordata	80,625	395,006	395,006	100,660	2,380

*Price derived from a young plant with rootball and stem circumference 14–16 cm

Table 8. Characteristics of landscaping value degrees (LV)

Landscaping value degree		Description
1	Very high	Tree with ideally developed habitat, corresponding with the given taxon and age; mostly solitary wit regular branching, fully vital, sound, undamaged, safe; very significant both functionally and compositionally on the site with long-term perspective
2	High	In all quantitative and qualitative markers, tree departs only slightly from relevantly aged ideal (LV 1); the departures, however, are not detrimental to its typical appearance, condition, function, and safety; significant both functionally and compositionally on the given site with long-term perspective
3	Average	Showing more conspicuous departures from ideal habitat at relevant age; shows slight or more serious physiological disorders or defects in its architecture; overall condition, damage and stability, however, do not reduce its relatively favorable functionality and safety, still allowing its mid-term to long-term existence
4	Low	Tree with considerably damaged habitat, e.g., due to crown closure, diseases, permanently active pests, age or absence of professional care; insufficiently enfoliated, weakly to very weakly vital, during maturity and senescence considerably unsafe for its immediate vicinity; with very limited functionality, with short-term expectancy, non-perspective
5	Very low (zero)	Little or no vitality, seriously ill, with little foliation, dying or dry in its entirety; habitat seriously damaged, in maturity and senescence unsafe to dangerous; nonfunctional and without perspective

The calculated indicative base tree prices were subsequently (Table 7) compared with base prices utilized by the existing Czech guidelines for woody species assessments (Grulich et al. 1992; Kolařík et al. 2005; Decree of the Ministry of Finance No. 3/2008 Coll.). These were, according to their authors, also calculated using the cost-based method, therefore they can be verified by comparison. The table clearly demonstrates that reference prices calculated in Czech economic environment by using Koch method (Hötzel, Hund 2001) or the reference prices included in the directive for practical use (Schulz et al. 2002) are, in their maximum, altogether manifold lower than those calculated by the so far used method for evaluating the extent of woody species damage and the determination of replacement planting price (Grulich et al. 1992; Kolařík et al. 2005). The newly fixed prices are closer to those listed in the currently valid regulation (Decree of the Ministry of Finance No. 3/2008 Coll.). The examples include only one exception, i.e., taxon *Prunus serrulata* Kanzan; its price listed in the Decree is evidently too high. The calculated base prices are comparable with indicative tree prices in Germany where, at present, interest rate of 4% applies.

Table 9. Translation key for base price deductions using the landscaping value criterion

Landscaping value		Base price (%)	Base price deduction (%)
1	Very high	100	0
2	High	80–99	1–20
3	Average	50–79	21–50
4	Low	10–49	51–90
5	Very low (zero)	0–9	91–100

Koch method does not end up by calculating total tree-growing costs up to its maturity (base price). It winds up by calculating the so-called material value, based on the present condition of a woody plant, when the calculated base price is being adjusted to reflect deductions for age, defects and damage. To achieve this, it uses formulas and tables. While testing individual age deduction calculating formulas, we identified quite significant result discrepancies as well as practical problems associated with determining both the sufficiently accurate current age and life expectancy of specific trees. We also found out that deductions on account of defects and damage may not always reflect all deficiencies of a given woody plant. Thus, we abandoned the original method when calculating the resulting evaluation price; instead, in order to adjust base prices in our conditions, we applied an indicator by which we evaluate the overall woody plant quality and potential. This indicator is known among professional public as landscaping

Table 10. Examples of base price deductions (%) set by a degree of landscaping value (LV) and resulting current tree prices (CZK). The prices are based on young tree with the size of stem circumference 14–16 cm

Woody plant	LV 1 (CZK)	LV 2		LV 3		LV 4		LV 5	
		(%)	(CZK)	(%)	(CZK)	(%)	(CZK)	(%)	(CZK)
Acer platanoides Globosum	29,450	10	26,505	25	22,088	60	11,780	95	1,488
Acer pseudoplatanus	78,381	5	74,462	25	58,786	80	15,676	95	3,919
Alnus glutinosa	31,172	10	28,055	30	21,820	90	3,117	98	623
Corylus colurna	69,387	15	58,979	50	34,684	80	13,877	95	3,469
Platanus × *acerifolia*	80,711	20	64,569	40	48,427	70	24,213	95	4,036
Prunus serrullata Kanzan	32,861	10	29,575	40	19,717	60	13,144	98	657
Quercus robur	121,643	20	97,314	30	85,150	70	36,493	98	2,433
Tilia cordata	80,625	15	68,531	50	40,313	80	16,125	98	1,613

value. The landscaping value scale proposed for the evaluation purposes (see Table 8) draws on previous classifications (Machovec 1970; Šimek 2001). Unlike those classifications, it ceased to take into account the woody plant age. The appropriate scale modification allows that even young, solitary, vital, still maturing (growing) specimens in their typical habitat can attain the highest scoring degree. Thus, price distortions related to young and maturing trees are being prevented; these trees were, according to the original classification, scored by grade three. Base price deductions are carried out using the proposed translation key (see Table 9). Percentage range assigned to individual scoring degrees make it possible for every assessor to apply his/her expert opinion as regards the quality and, consequently, the resulting price of the woody plant. Table 10 presents examples of woody plant prices that were modified using the described indicator. These prices are termed as final, resulting (assessment) woody plant prices; their calculation was our initial aim.

The second tree price calculating modification of Koch method introduced in our conditions concerns the application of landscaping value indicator.

By using the described procedure, it is possible to calculate both the base and the resulting (evaluation) price of any tree species and/or cultivar.

CONCLUSIONS

Domestic testing of Koch method for ornamental trees evaluation has demonstrated that this method based on interest paid on invested costs is relatively simple, professionally transparent and easily checked. By utilizing the procedure, one can set the price of a given woody plant both in its nominal condition (base price) and in its actual (real, current) condition. The latter is termed as the resulting (evaluation) price and/or material value of a tree. Koch method can be used to calculate both base and resulting price of any tree species or cultivar, irrespective of whether one knows or does not know its dimensions (size). The only necessary input data include material and labor costs associated with its growing into completely mature, fully stabilized condition as well as the knowledge of current tree quality. The most important material costs embrace the choice of proper young plant size which should always correspond with the significance of the tree for the given site.

Calculations that were conducted indicate that prices of individual taxa may differ considerably. The differences are caused, in particular, by the following factors: tree species (cultivar) itself, chosen young plant size, genetic qualities of the evaluated taxon – and above all, speed of maturation growth and crown size. Price levels are also considerably affected by relevant interest rates. The interest rate of 7% is the initial rate specially calculated for Koch method application in Czech domestic conditions. At the same time, it represents the opening cue for professional debate on this topic.

Comparisons of base prices of selected trees have indicated that the corresponding prices quoted in current Czech manuals are manifold higher. Thus, the demand for price change appears to be legitimate as Koch method is based on real costs.

While Koch method was being tested in this country, two modifications were proposed to be made in the calculation construction. One is related to making provision for tree growth qualities when

calculating development care costs, the other is associated with landscaping value application when determining the level of deductions linked with the actual condition of the given woody plant.

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Testování Kochovy metody oceňování okrasných stromů v České republice

ABSTRAKT: Kochova metoda oceňování okrasných stromů je založena na úročení nákladů vynaložených na jejich pěstování do stadia plné funkčnosti, od kterých se odečítají srážky za stáří, vady a poškození. Cílem práce byla aplikace této metody v ekonomických podmínkách České republiky. Příspěvek uvádí potřebná ekonomická data vytvářená podle technologického modelu pěstování stromu na trvalém stanovišti. Prezentován je i mechanismus výpočtu tzv. základní ceny stromu jako základny pro odpočet srážek podle jeho aktuálního stavu. Vypočítané základní ceny stromů jsou na příkladech porovnávány s úrovní cen v dosud používaných metodikách a právním předpisu. Řeší se i způsob úpravy základní ceny, a to podle kritéria sadovnická hodnota stromu. V mechanismu výpočtu cen byly při testování Kochovy metody uplatněny dvě modifikace. První se týká zohlednění růstových vlastností v kalkulaci nákladů rozvojové péče, druhá zavedení ukazatele sadovnická hodnota jako jediného kritéria úpravy základní ceny na cenu výslednou, odpovídající aktuálnímu stavu stromu.

Klíčová slova: Kochova metoda; oceňování dřevin; okrasné stromy; náklady na pěstování; rozvojová péče; základní cena; výsledná cena; sadovnická hodnota

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