Determining the Initial Reference Price of a Used Vehicle for Expert Valuation

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Abstract

The determination of the initial reference price is a decisive step in expert valuation of used passenger vehicles because it affects the calculated time value, the marketability coefficient, and the final market value. The paper compares three approaches to determining the initial reference price: the original price list valid when the vehicle was first registered, the current price list of a comparable new vehicle adjusted by a technical-level coefficient, and the original price list adjusted by a motor-vehicle inflation index. Five valued vehicles and ten verified comparable vehicles for each model were analysed. The methods were evaluated using the marketability coefficient and its absolute deviation from the ideal value of 1. The inflation-adjusted original price list produced the most stable overall results and the lowest average deviation for four older vehicles. For the youngest vehicle, Volkswagen Passat, the current and original price-list methods were very close, so the current price list can be interpreted as suitable or comparable rather than unequivocally superior. The findings support a transparent procedure combining historical price evidence, macroeconomic price development, and verified market data.

Keywords: vehicle valuation, initial reference price, marketability coefficient, Expert Standard I/2022, used cars, inflation

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Introduction

Valuation of road vehicles is a regular component of judicial, insurance, leasing and financial practice. It is used in property disputes, insurance claims, tax evidence, lease settlements and the valuation of damage or technical appreciation. In all these settings, the credibility of the valuation depends not only on the final amount but also on the transparency of the method by which the amount was obtained. This is especially important for used vehicles, where the market price is shaped by technical condition, mileage, service history, equipment, brand reputation, customer preferences, and the wider economic environment.

The Czech expert-valuation environment has historically relied on codified procedures developed by the Institute of Forensic Engineering of Brno University of Technology. Expert Standard I/2005 provided a reproducible framework based on the price of a new vehicle, age and mileage-related amortisation, and expert corrections for technical condition and equipment

(Bradáč and Krejčíř, 2004). Expert Standard I/2022 retained the core logic of technical valuation but strengthened the role of market evidence, database records and documented comparison samples (Kledus, Bradáč and Ševčík, 2021). This shift reflects the broader international move from static tables toward valuation supported by real market data, digital vehicle-history records and statistical modelling.

The initial reference price is the key input examined in this paper. If it is underestimated, the calculated time value will also be underestimated, and the resulting marketability coefficient will signal an apparent mismatch with market prices. If it is overestimated, the opposite distortion occurs. The issue became particularly relevant after the sharp increase in prices of new and used vehicles in the period affected by supply-chain disruption, inflation, and changing customer demand. A historical price list alone may fail to reflect the current price level, while a current price list may represent a newer technological generation that is not fully comparable with the valued vehicle.

The aim of the paper is to compare three methodological approaches to determining the initial reference price of used passenger vehicles and to assess their accuracy, variability and practical applicability in expert valuation.

In relation to this aim, the following research questions are formulated:

RQ1: Which of the selected methods for determining the initial reference price of a vehicle provides the highest agreement with observed market asking prices?

RQ2: What differences do the individual methods for determining the initial reference price of a vehicle show in terms of the achieved marketability coefficient values?

RQ3: What is the variability and stability of the results of the individual methods, and what is their significance for valuation practice?

RQ4: What recommendations for selecting a suitable procedure for determining the initial reference price of a vehicle can be formulated on the basis of the obtained results?

Literature Review

The academic and professional literature confirms that used-vehicle prices are determined by a combination of technical, economic and behavioural factors. Traditional econometric and hedonic models decompose the vehicle price into attributes such as age, mileage, make, model, power, fuel type, equipment and region. More recent work applies ensemble learning and machine-learning methods to larger datasets. Random Forests and related ensemble models are able to capture nonlinear relationships among attributes and have repeatedly been shown to improve predictive performance compared with simpler regression models (Breiman, 2001; Chen, Li and Xu, 2021). Bergmann, Lessmann and Voss (2025) further demonstrate that granular equipment information can increase the accuracy of used-car resale price forecasts because equipment packages and optional features materially influence resale value.

However, expert valuation cannot be reduced to predictive accuracy. In judicial and insurance contexts, the valuation procedure must be explainable, auditable and defensible. This is why black-box models remain problematic even where they achieve low predictive error. Rudin (2019) argues that high-stakes decisions should prioritise interpretable models rather

than post-hoc explanations of opaque models. Molnar (2022) similarly presents explainability as a necessary condition for using complex models responsibly. In the vehicle-valuation context this means that machine-learning tools may support analysis, but the final expert reasoning must still be traceable to observable inputs, documented adjustments and a clearly stated comparison sample.

The quality of market data is equally important. Czech practice increasingly uses systems such as CEBIA Autotracer and Market Price Analysis, which provide data on vehicle identity, service records, mileage consistency, accident history, ownership and comparable market offers (CEBIA, 2025a; CEBIA, 2025b; CEBIA, 2025c). These sources reduce information asymmetry, but they do not remove the need for expert judgement. Advertised prices may differ from realised transaction prices because of bargaining, discounts and dealer policy. Busse, Knittel and Silva-Risso (2013) and Langer (2011) show that automotive list prices and actual transaction prices can diverge substantially, which supports the use of the marketability coefficient as a practical correction mechanism.

A further strand of literature concerns price-level changes and durable goods. Diewert (2020) and OECD (2021) emphasise that the valuation of consumer durables must distinguish between nominal price changes, physical depreciation and user cost. For vehicles, inflation adjustment alone cannot determine market value because physical wear, technical obsolescence and market preferences remain decisive. Nevertheless, adjusting a historical list price by a relevant motor-vehicle price index can provide a transparent analytical bridge between the vehicle configuration at first registration and the current price level. This is precisely the role of the inflation-adjusted method tested in the empirical part of the paper.

Current technological changes reinforce the need for careful method selection. Electric vehicles, digital equipment and driver-assistance systems alter the composition of vehicle value. Battery state of health is a key determinant in the secondary market for electric vehicles, and the literature stresses the importance of transparent battery information for consumer confidence and residual value (Fanoro et al., 2022; Diouf and Gandolfo, 2025). Although the empirical sample in this paper contains conventional vehicles, these developments illustrate why a current price list may represent a different technological standard than the valued vehicle and why a technical-level coefficient may be needed.

The reviewed literature also supports retaining the marketability coefficient as the central evaluation indicator. KP [the marketability coefficient (KP; Czech: koeficient prodejnosti)] connects the technical calculation with the observed market and shows whether the selected initial reference price produces a time value consistent with comparable vehicles. In that sense it is not merely a final correction coefficient; it is also a diagnostic tool for assessing whether the underlying reference price was chosen appropriately.

The literature review therefore leads to a practical methodological implication: an expert valuation method must be sufficiently data-oriented to reflect the current market, but sufficiently transparent to remain defensible in an expert report. A purely historical catalogue value is easy to document, but it may ignore the current price level. A purely current catalogue value reflects current prices, but it may import technological and equipment differences from a newer model generation. A purely predictive model may be accurate in a large dataset, but it

may be difficult to justify in an individual valuation unless the data, variables and model logic are fully documented. The three methods tested in this paper were selected precisely because they represent these competing logics in a form usable in expert practice.

Data and Methods

The empirical analysis uses five valued vehicles selected from public advertising sources in the Czech market: Skoda Octavia Combi 2.0 TDI DSG, Skoda Fabia 1.0 TSI, Skoda Karoq 1.5 TSI DSG, Hyundai Tucson 1.6 CRDI and Volkswagen Passat Variant 2.0 TDI DSG. The vehicles were selected to cover several common market segments and first-registration years from 2016 to 2021. Each valued vehicle was accompanied by ten comparable vehicles of similar type and specification. Comparable vehicles were included only where service history, mileage consistency and the absence of serious accident records could be verified, primarily through CEBIA-based checks.

Table 1: Valued vehicles in the empirical sample

Vehicle	First registration	Mileage	Fuel/engine	Transmission	Residual usability ZU	Main segment signal
Skoda Octavia Combi	2018	239,032 km	2.0 TDI, 110 kW	DSG	23.1%	company/family estate
Skoda Fabia	2018	32,073 km	1.0 TSI, 70 kW	manual	54.2%	small hatchback
Skoda Karoq	2018	126,287 km	1.5 TSI, 110 kW	DSG	40.0%	SUV
Hyundai Tucson	2016	97,622 km	1.6 CRDI, 85 kW	manual	40.3%	SUV
Volkswagen Passat Variant	2021	176,555 km	2.0 TDI, 110 kW	DSG	40.0%	young estate vehicle

Source: Own processing based on the vehicle-identification and amortisation data from the original thesis.

Three approaches were compared. The first method used the original price list valid when the vehicle was first registered. The second method used a current price list for a comparable new vehicle and, where necessary, applied a technical-level coefficient (KTU) to reflect the lower technical level of the valued vehicle compared with the current model. In the analysed cases, KTU was set at 0.9. The third method used the original price list and adjusted it by the HICP index for new motor cars from Eurostat (Eurostat, 2026).

The inflation coefficient was calculated as the ratio between the HICP annual average index for new motor cars in the valuation year and the corresponding index in the year of first registration.

The calculation followed the logic of Expert Standard I/2022. First, the initial reference price (HN) was determined by each of the three methods. Second, basic amortisation (ZA) was calculated as the arithmetic mean of the age-related deduction (ZAD) and mileage-related deduction (ZAP). Third, residual usability was calculated as ZU = 100 - ZA. Fourth, the time value of the vehicle was determined as HC = HN x ZU / 100. Finally, the marketability coefficient was calculated for comparable vehicles as the ratio between market price and

calculated time value; the average of individual coefficients gave the overall KP for the comparison set. The market value of the valued vehicle was then obtained as HTv = HCv x KP.

The methodological structure was expressed through the following equations. The initial reference price was tested in three variants:

$$HN_1 = P_{original}$$
$$HN_2 = P_{current} \times KTU$$
$$HN_3 = P_{original} \times I_{HICP}$$

where HN is the initial reference price, P_original is the original list price valid at first registration, P_current is the current price of a comparable new vehicle, KTU is the technical-level coefficient, and I_HICP is the motor-vehicle inflation index.

The subsequent valuation calculation followed the standard amortisation and market-correction logic:

$$ZA = \frac{(ZAD + ZAP)}{2}$$
$$ZU = 100 - ZA$$
$$HC = HN \times \frac{ZU}{100}$$
$$KP_i = \frac{MP_i}{HC_i}$$
$$KP = \left(\frac{1}{n}\right) \times \Sigma\, KP_i,\ n = 10$$
$$HT_v = HC_v \times KP$$

where ZA is basic amortisation, ZAD is the age-related deduction, ZAP is the mileage-related deduction, ZU is residual usability, HC is time value, MP is the observed market price of a comparable vehicle, KP is the marketability coefficient, and HTv is the resulting market value of the valued vehicle.

The evaluation criterion was the distance of KP from the ideal value of 1. A KP above 1 indicates that the calculated time value is lower than the observed market level; in other words, the method tends to understate the reference base. A KP below 1 indicates that the calculated time value exceeds the observed market level. Absolute deviation was therefore used as the main accuracy measure, while the distribution and variability of KP values were used to assess stability.

$$AD_{KP} = |KP - 1|$$

The choice of ten comparable vehicles for each valued vehicle follows the logic of Expert Standard I/2022 and creates a practical compromise between market representativeness and comparability. A larger set may increase statistical volume but can also introduce vehicles with materially different mileage, equipment or history. The thesis therefore prioritised verified comparability over mechanical sample size. This is important because the aim was not to build

a general predictive market model, but to test how the selected initial-price method behaves inside an expert valuation procedure.

For the purposes of the article, the extensive vehicle-by-vehicle calculations from the thesis were condensed into the variables that directly affect the comparison of methods. Detailed equipment lists, VIN records and individual comparable-vehicle rows were not reproduced in full because they would exceed the article format. They were nevertheless used in the original calculations to determine comparability, amortisation and the average KP values. The retained tables therefore focus on the decision-relevant values: first-registration year, mileage, residual usability, initial reference prices, valuation intervals and KP deviations.

Results

The initial reference prices differed substantially across the three methods. For the older vehicles, the original price list was usually much lower than the inflation-adjusted original price. The current price-list method sometimes produced values close to the inflation-adjusted method, but this depended on the comparability of the current model and the model being valued. In the Volkswagen Passat case, the vehicle was the youngest in the sample and the time gap between first registration and current price list was shorter; consequently, the current and original approaches were both close to the market level.

Table 2: Initial reference prices and valuation intervals

Vehicle	Original list price CZK	Current list price x KTU CZK	Original list price x inflation CZK	Valuation interval CZK	Best or comparable fit
Skoda Octavia	773,900	854,910	898,498	203,000-218,000	inflation-adjusted original
Skoda Fabia	315,000	404,910	406,350	224,000-251,000	inflation-adjusted original
Skoda Karoq	690,000	693,000	890,100	377,000-385,000	inflation-adjusted original
Hyundai Tucson	579,990	715,491	781,827	335,000-342,000	inflation-adjusted original
Volkswagen Passat	990,000	1,109,113	1,056,726	375,000-385,000	current and original close

Source: Own processing based on original price lists, current price lists and Eurostat HICP data.

For Skoda Octavia, the KP values were 1.27 for the original price-list method, 1.23 for the current price-list method and 0.98 for the inflation-adjusted original price list. The third method was therefore closest to the ideal value, with only a 2% deviation. For Skoda Fabia, the same ordering was observed: the original method reached KP = 1.31, the current method KP = 1.14 and the inflation-adjusted method KP = 1.05. Although the Fabia had very low mileage compared with many market comparables, the inflation-adjusted method remained the closest to the market level.

The SUV models showed stronger marketability. Skoda Karoq reached KP = 1.37 under the original price-list method and KP = 1.36 under the current price-list method, while the inflation-adjusted original price list reduced the coefficient to 1.08. Hyundai Tucson showed a similar pattern, with KP = 1.44, 1.17 and 1.09 respectively. These results suggest that SUV demand can lead to higher observed market prices relative to technically calculated values, but the inflation-adjusted historical price still produced the closest alignment.

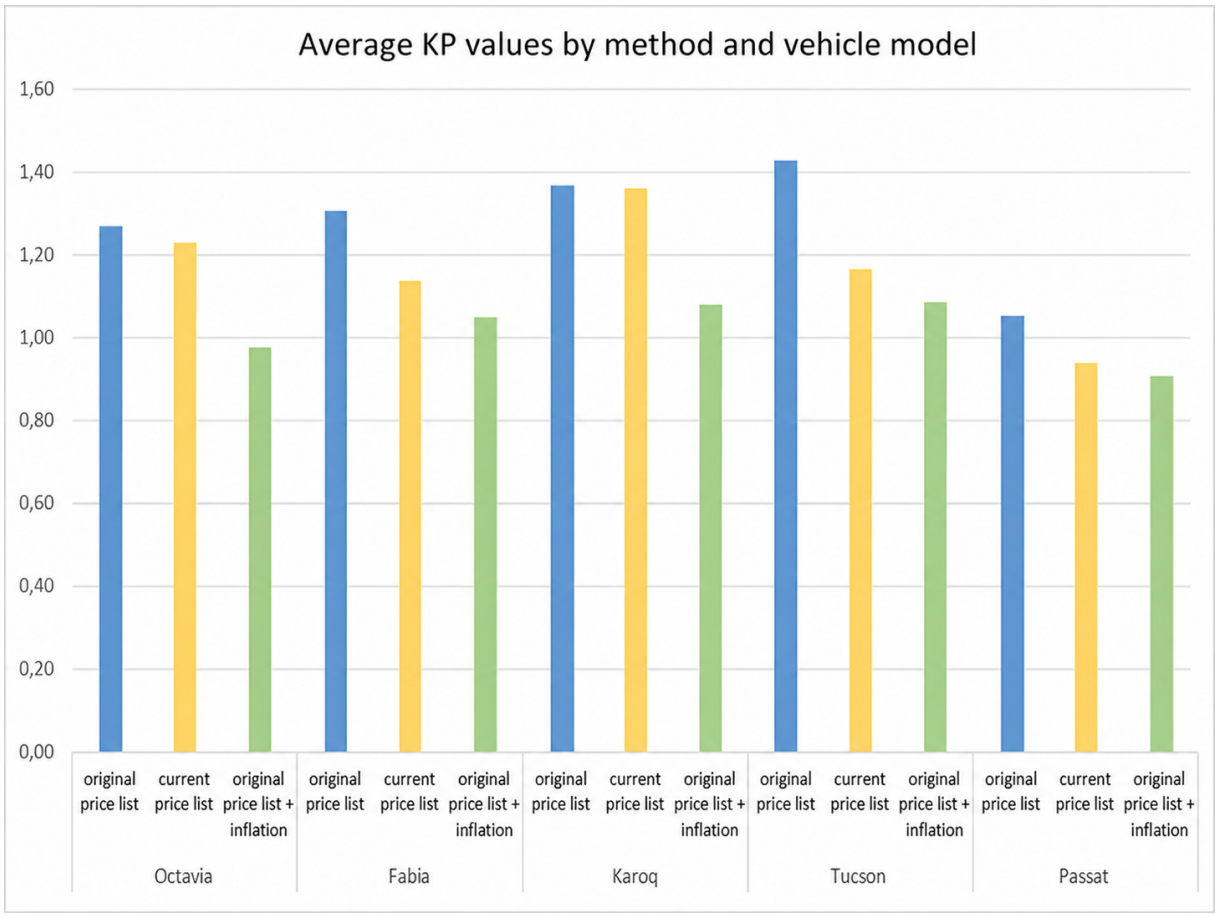
The Volkswagen Passat differed from the other vehicles. It was first registered in 2021 and was therefore considerably younger. The original method produced KP close to 1, while the current price-list method was also very close. The result should therefore not be interpreted as a case where the current list price was unambiguously the best method. Rather, it shows that for a younger vehicle with a shorter distance from current model conditions, the current price-list method may be suitable and comparable with the original list-price approach. This is consistent with the practical expectation that current list prices become more problematic as model generations, standard equipment and technology diverge over time.

Table 3: Average KP values and absolute deviations from the ideal value

Vehicle	KP original	KP current	KP original x inflation	Abs. dev. original	Abs. dev. current	Abs. dev. inflation	Interpretation
Skoda Octavia	1.27	1.23	0.98	0.27	0.23	0.02	inflation adjustment closest
Skoda Fabia	1.31	1.14	1.05	0.31	0.14	0.05	inflation adjustment closest
Skoda Karoq	1.37	1.36	1.08	0.37	0.36	0.08	inflation adjustment closest
Hyundai Tucson	1.44	1.17	1.09	0.44	0.17	0.09	inflation adjustment closest
Volkswagen Passat	1.05	0.94	0.91	0.05	0.06	0.09	original/current very close
Overall average	1.29	1.17	1.02	0.29	0.19	0.07	inflation adjustment most stable overall

Source: Own processing based on the original thesis results.

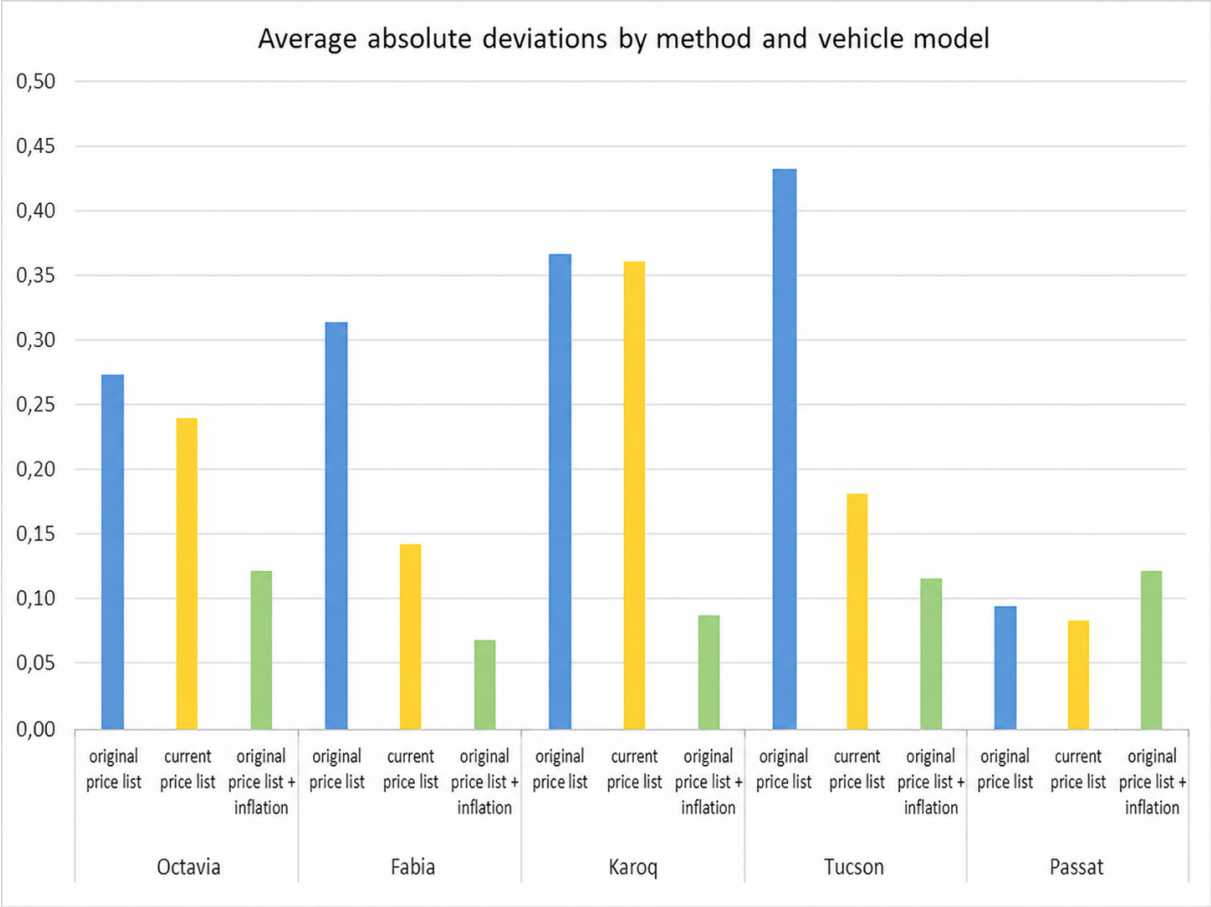
Figure 1: Average KP values by method and vehicle model



Source: Own processing, adapted from the original thesis chart.

The overall comparison confirms that the inflation-adjusted original price list achieved the average KP closest to 1. The original price-list method produced the largest average deviation because historical nominal prices no longer reflected the market price level. The current price-list method improved the average result, but its higher sensitivity to model comparability reduced its stability for older vehicles.

Figure 2: Average absolute deviations by method and vehicle model



Source: Own processing, adapted from the original thesis chart.

The distribution of deviations also matters. The original thesis showed that the inflation-adjusted method had the highest concentration of KP values in the interval nearest to 1, particularly between 0.98 and 1.04. By contrast, the original price-list method concentrated many values above 1.2, which indicates systematic understatement of the technical value relative to the observed market. The current price-list method was more balanced than the original method but still less consistent than the inflation-adjusted method across the full sample.

Discussion

RQ1: Which of the selected methods for determining the initial reference price of a vehicle provides the highest agreement with observed market asking prices?

The inflation-adjusted original price list provided the highest overall agreement with market prices. This method combines two advantages. It preserves the specific historical configuration of the vehicle at first registration, and it also updates the nominal price level to reflect the development of new-vehicle prices. The method is therefore well suited to vehicles where the original specification can be documented and where several years have passed since first registration.

RQ2: What differences do the individual methods for determining the initial reference price of a vehicle show in terms of the achieved marketability coefficient values?

The original price-list method was transparent but too static during a period of price growth. It produced KP values above 1 for all vehicle models, which means that the calculated time values were generally lower than market prices. The current price-list method partially corrected this problem but introduced another one: the current new vehicle may differ in technology, safety equipment, emissions standards, digital systems and standard equipment. This makes the technical-level coefficient important but also introduces expert judgement. The inflation-adjusted method reduced both weaknesses by retaining the original vehicle configuration and adjusting only the price level.

RQ3: What is the variability and stability of the results of the individual methods, and what is their significance for valuation practice?

The lower absolute deviations and more balanced KP distribution show that the inflation-adjusted original price list was the most stable method in the analysed sample. Its stability was strongest for the four older vehicles. The Passat result is more nuanced: both the original and current methods were close to the ideal value, and the current method can be considered suitable for this younger vehicle. The finding supports a conditional recommendation rather than a universal rule. Current list prices are useful where the current model is still directly comparable; they become riskier where there has been a major generational change.

RQ4: What recommendations for selecting a suitable procedure for determining the initial reference price of a vehicle can be formulated on the basis of the obtained results?

For vehicles older than approximately three years, the inflation-adjusted original price list should be treated as the preferred starting point if the original price list and equipment level can be reliably documented. The current price-list method should be used as a control or alternative mainly for newer vehicles, vehicles without substantial generational change, or cases where the original list price is unavailable. The unadjusted original list price should not be used as a sole reference in periods of significant inflation because it tends to understate the reference base.

The analysis also highlights the role of the comparison sample. The original thesis evaluated the relationship between mileage dispersion and KP variability. Higher dispersion in comparable-vehicle mileage can increase the variability of KP because mileage is one of the key determinants of used-vehicle value. This means that the expert must not only calculate KP mechanically but also review whether the ten comparable vehicles are sufficiently close in mileage, equipment, service history and market positioning. A formally large comparison set can still be weak if its technical comparability is poor.

The SUV results also deserve attention. Škoda Karoq and Hyundai Tucson recorded relatively high KP values under the original and current methods, which may reflect stronger market preference for SUV body types. Marketability is therefore not purely a technical outcome. It also captures demand patterns, perceived utility, brand and body-type preferences.

This supports the use of KP as a market correction tool, while also confirming that the coefficient must be interpreted in context rather than treated as a purely mathematical residual.

This recommendation does not remove the expert role. On the contrary, it clarifies where expert judgement is most needed: in documenting the original configuration, assessing whether the current model is truly comparable, choosing and verifying comparable vehicles, interpreting mileage dispersion and deciding whether market preference for a body type or brand affects KP. The method is therefore best understood as a structured decision aid rather than an automatic rule.

Taken together, the research questions can be answered as follows. First, the inflation-adjusted original price list provided the strongest overall agreement with market prices. Second, the original price list without inflation correction showed systematic upward KP values, while the current price-list method produced intermediate results and was most useful where model comparability remained high. Third, the inflation-adjusted method was the most stable across the sample, although the Passat case shows that younger vehicles require a more nuanced interpretation. Fourth, valuation practice should use the inflation-adjusted original price list as the preferred reference for older vehicles, the current list price as a control for young or directly comparable models, and the unadjusted original list price only with caution.

Conclusion

The paper compared three approaches to determining the initial reference price of used vehicles for expert valuation. The original price list adjusted by a motor-vehicle inflation index produced the best overall agreement with market prices and the lowest average absolute deviation of KP from the ideal value of 1. The unadjusted original price list was transparent but systematically less accurate for older vehicles because it ignored price-level development. The current price-list method was useful mainly where the valued vehicle remained close to current model conditions.

The Volkswagen Passat case confirms that the interpretation must remain nuanced. Because it was the youngest vehicle in the sample, the current price-list method was suitable and comparable with the original method, but it should not be presented as unequivocally superior. The broader conclusion is that method choice should depend on vehicle age, model continuity, availability of historical price information and the quality of comparable market data.

For expert practice, the recommended procedure is to use the inflation-adjusted original price list as the primary reference for vehicles several years old, to verify the result against current price-list evidence where the current model is comparable, and to support the final value with a carefully selected set of verified comparable vehicles. This combination respects the transparency required in expert valuation while responding to real market and macroeconomic conditions.

Contribution and Limitations

The main contribution of the paper is the empirical verification of three transparent methods for determining the initial reference price. The comparison is useful for expert practice because it focuses on a specific input that strongly affects the final valuation but is often hidden inside the broader calculation. By evaluating the methods through KP and absolute deviation from 1,

the paper offers a reproducible framework for assessing whether the initial reference price is consistent with market evidence.

The practical contribution is also methodological. The paper shows that a combination of historical documentation, inflation adjustment and market comparison can preserve auditability without ignoring market development. This is important because fully data-driven models may be more accurate in large datasets but can be difficult to defend in individual expert reports if their internal logic is not transparent. The proposed approach remains compatible with Expert Standard I/2022 because it uses market data and expert comparison while keeping the calculation steps explicit.

The limitations are clear. The empirical sample contains five valued vehicles and fifty comparable vehicles, so the results should not be generalised mechanically to all vehicle classes. The analysis is also tied to a specific market period affected by inflation and post-pandemic disruption. Exact original transaction prices were not available, and the work therefore relied on historical price lists rather than actual purchase invoices. Future research should expand the sample, include additional brands and age groups, test electric and hybrid vehicles separately, and analyse how mileage dispersion, equipment packages and service-history quality affect KP stability.

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