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An Econometric Model of the Materials – Market Relation in the Auto Body Car Manufacturing

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ABSTRACT

An input-output econometric model was constructed for the body car manufacturing. The model generated is a combined model consisting mainly of classical input-output model, flow graph theory, and econometric models distinct from input-output models. Major outputs of the model consist of an optimal dynamic system models. The optimal dynamic system models consist of a dynamic (multi-period) input-output model and a production system models. The input-output econometric model as constructed and defined exhibits the flexibility and feasibility necessary for use in an interactive decision support system.

Keywords: *econometric model, auto body car manufacturing, genetic algorithm*

1. Introduction

An econometric model is a mathematical representation of relationships in the economy - often highly complex ones - expressed as equations. The equations explain how one economic variable can change as a result of changes in other key variables. For instance, an econometric equation could be derived to explain changes in saving behaviour over time as it is affected by trends in incomes and interest rates. Econometric models are not perfect, but they often provide an approximation that is useful when trying to understand and forecast changes in the economy. Many authors introduce the econometric models in order to make prediction of the economical bahaviour considering the main factors that affect the price and production. The econometric models encountered stagnation in developing and their application, around the years 1990s, probably because of the impossibility to solve in an easy and attractive way the equations. Recently, with the help of the new modeling methods, such as artificial intelligence, this subject reveal new implementations and open a new gate for industrial economic research.

In order to understand how changes in technology and/or public policy are likely to affect the rate of material throughput, one needs something more than just a general description of the entire materials transformation process. A somewhat narrower focus is called for which gives detailed information about factors affecting the rate of flow of secondary materials at specific points in the flow process. In this regard, economic concepts of supply and demand can be brought into play. It is often useful to choose a particular point in the materials flow at which the preceding production activities are viewed as supplying secondary materials and the production and consumption activities which follow are viewed as creating demand for secondary materials. One then attempts to identify parameters which affect the rate at which producers are willing to supply secondary materials, and parameters which affect the rate at which other producers or final consumers wish to consume secondary

materials. Taken together these two sets of factors should determine the flow rate which actually prevails at this point. If in addition one is able to relate changes in public policy or technology to changes in the values of one or more of the parameters influencing supply and demand it is then possible to predict the effect upon the recycling rate of specific changes in upgrade the secondary materials which they themselves generate.

2. Pricing in the automobile industry

In the manufacturing of the automotive bodies cars, the cost changes are the main determinant of price changes. In the short run production, the average cost of production declines over a relatively wide range of output. For one year cost model of one automotive bodies company, fixed costs (design, materials, development and tooling costs) together with plant overheat account for over 40 percent of wholescale price. The average costs are sensitive to the volume of production, even with no variation in short run or variable factor costs. If the automotive manufacturers are basing price on average costs, expected deviations in output between model years could significantly affect prices without any change factor costs. Additionally, the higher fixed costs as a proportion of total costs, the more sensitive is short run marginal cost to changes in the costs of the variable factors of production [1,2].

Thus, the low proportion of variable costs in the auto industry would make short run marginal costs especially sensitive to variable factor price changes. If firms are short-run profit maximizers, prices should respond positively to changes in variable factor costs. In figure 1 there are shown the components of the cost of one body car. Tha partially cost is determined by *material data* (1) - dimensions and weight of the body that means quantity of the material used, quality and grade of material used and fabrication costs (stamping/casting/bending or deep-drawing) (2). These two components determine the part costs. Assembly cost is determined by design itself and joining method (1) and assembly model (2), that nowadays is analysed mainly by finite element simulation. Finally, the part cost and assembly cost is included in the body cost containing fabrication and assembly. The input of the econometric problem is the material used, design and technology and the output problem is the cost of the body cars.

To determine a relation between input and output and, moreover, to estimate its evolution indeed the variables are continuing changing technology or public policy. The question which immediately arises is what are the important points in the flow to which our attention should be directed. Most discussions of recycling treat as supply activities those engaged in by scrap dealers and those engaged in by individuals or firms that prepare or

(new grades of materials ocuur, new technologies, new methods of design) means to create the econometric model. This model is useful in precition of the costs at one moment by taking into account the state variables of the market.

3. The econometric model

The model that has been estimated in a single equation [] has the following relation:

$$P_t = a_0 + a_1 V_t + a_2 C_{t-1} \qquad (1)$$

where the variables are

P_t - a wholesale price index for automobiles in the year t;

V_t - a variable indicating expected growth in sale volume for year t;

C_{t-1} - a composite index of labor and material factor prices for the industry for year t-1.

Identification of the polinomial function (1), a_0, a_1 and a_2 means to find the optimum set of values so that the cost function (P_t) to be minimum. This problem of optimisation can be solved by using genetic algorithms.

To apply genetic algorithms mean to define the range within the parameters a_0, a_1 and a_2 takes the values. This interval is set up through determining the minimum and maximum values of the parameters, for a period, that in the present paper is year 1992 – year 2005.

The evolution of V_t and C_{t-1} concurrent with the price evolution is analysed based on the data announced by automotive cars reports. The values obtained for C_{t-1}.

In figure 2 there are represented the evolution of the sales within three representative automotive makers and the other automotive makers that recently increases their number of automobiles. If the avarage of these prediction is considered, the value of Vt, where t is year 2006, is 5 200 000 units. In the period 1992-2006, the minimum and maximum value of the average Vt is [3800 000 – 5000000 units].

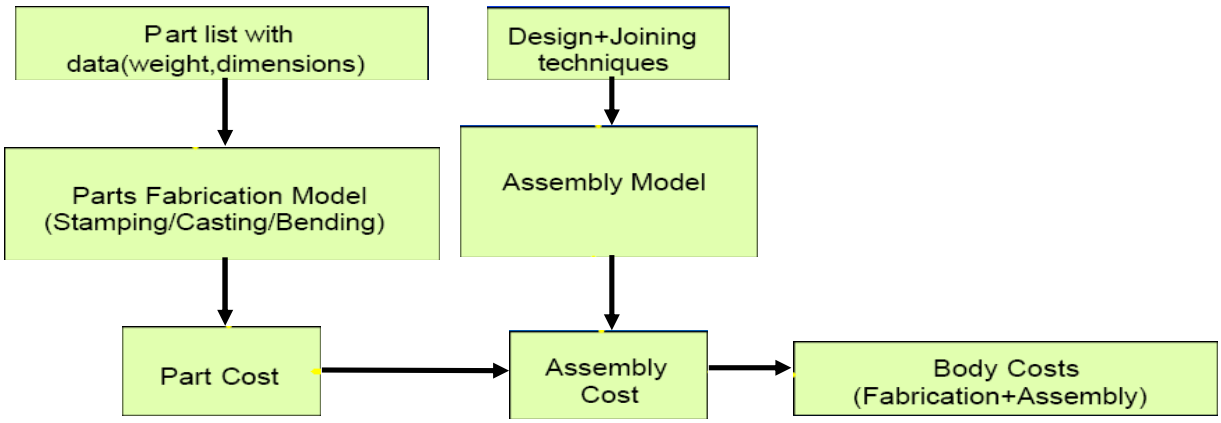

Fig. 1 – Methodology for design analysis for automotive body cars made of aluminium

EVOLUTION OF THE USE OF THE MATERIALS (Similar models in the same manufacturer)		
	Vehicle year 1992	Vehicle year 2005
Steel	63 %	46.2 %
Aluminium	6 %	19.5 %
Non-ferrous metal	See Others	2.5 %
Plastics	8 %	11 %
Rubber	3.5 %	3 %
Glass	See Others	3 %
Operational elements (Lubricants, paints, etc..)	4.5 %	6.4 %
Others	14%	8,4 %

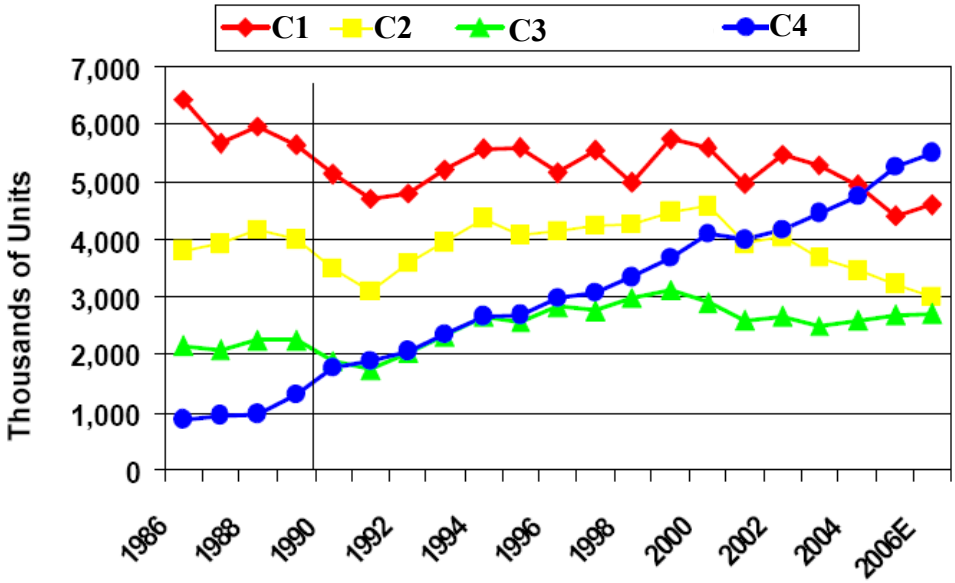

Fig. 2 – Evolution of the automobiles sales between 1986-2006.
C1, C2, C3 and C4 are automotive body makers

Indeed C_{t-1} and V_t are determined, the price evolution is necessary to be determined. Based on Blue Chip Economic Indicators, the price index for automobiles in year 2007 is 2.7%, less then the price index encountered in 2006. All the variables of equation (1) are determiend, so that the genetic algorithm is applied in order to find the best set of parameters that characterise the econometric model for the prediction variables at the level of year 2007.

4. Identification of the model parameters

For identification of the parameters of the econometric model (1), the genetic algorithms (GA) software GENESIS 2.0 is applied. GA is used to estimate dynamic nonlinear time-series models from nonstationary data. Specification search takes place at three different levels: between competing covariates, between different dynamic specifications, and across functional forms. A variation of GA is developed that operates on strings representing functional forms. Although the dimensionality of the specification space is very large, we show that GA succeeds in estimating strings that have straightforward economic interpretations. The nonstationarity of the data gives rise to the problem of spurious fitness in strings obtained by GA.
GA are based on an analogy with the genetic structure and behaviour of chromosomes within a population of individuals using the following foundations:

- Individuals in a population compete for resources and mates.
- Those individuals most successful in each 'competition' will produce more offspring than those individuals that perform poorly.
- Genes from "good" individuals propagate throughout the population so that two good parents will sometimes produce offspring that are better than either parent.
- Thus each successive generation will become more suited to their environment

A genetic algorithm with 3000 chromosomes and 200 generations was set up, and the restrucction in the evolution was set to find the minimum value of the equation (1). after 40 generations, the set of the identified parameters a0, a1 and a2 stabilized, so that ni improvements was obtained after this. With the determined values of a_0=1.234, a_1=8.E-6, a_2=0.532, the econometric model was identified. This model couald be used for prediction of the bevahior between the output – variable P_t – and the input – variables V_t and C_{t-1} – in the automotive makers. The advantage of this model is the dynamicity and flexibility that can take into account the rapid changes on the market.

5. Aknowledgements

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Un model econometric al relației materiale - piață în construcția de caroserii auto

Rezumat

Lucrarea prezinta un model econometric al relatiei intrare-iesire in cazul constructiei de automobile. Modelul generat este o combinatie a unui model clasic, ce ofera o relatie dintre intrare si iesire, dar identificarea acestuia se face printr-o metoda moderna de predictie si optimizare – metoda algoritmilor genetici. Modelul este un sistem dinamic, ce tine seama de evolutia materialelor folosite in constructia caroseriilor pe piata, dar si de evolutia vanzarilor si a costurilor automobilelor. Modelul econometric permite estimarea costurilor produselor, sau estimarea vanzarilor ceea ce determina reglarea productiei in vederea eficientizarii acesteia.

Ein Econometric-Modell der Materialien - Marktbeziehung in der Körperautoherstellung

Zusammenfassung

Eine Eingangsproduktion econometric Modell wurde für die Körperautoherstellung gebaut. Das erzeugte Modell ist ein vereinigtes Modell, das hauptsächlich aus dem klassischen Eingangsproduktionsmodell, Fluss-Graph-Theorie, und von Eingangsproduktionsmodellen verschiedenen Econometric-Modellen besteht. Hauptproduktionen des Modells bestehen aus optimalen dynamischen System-Modellen. Die optimalen dynamischen System-Modelle bestehen aus einem dynamischen Eingangsproduktionsmodell, und ein Produktionssystem modelliert. Die Eingangsproduktion econometric Modell, stellt wie gebaut und definiert die Flexibilität und Durchführbarkeit notwendig für den Gebrauch in einem interaktiven Entscheidungshilfe-System aus.