Journal of Namibian Studies, 33(2023): 1258–1287 ISSN: 2197-5523 (online)

# ANALYSIS OF CHANGES IN THE INPUT OUTPUT STRUCTURE OF DKI JAKARTA PROVINCE IN 2016 AND 2024: USING THE DYNAMIC INPUT OUTPUT (DIO) MODEL

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*Abstract*

*This study aims to look at the estimated structural changes in the input output table for DKI Jakarta Province in 2024. Estimates for changes in the structure are obtained by making projections of the input-output table for DKI Jakarta Province in 2024 using the Dynamic Input Output (DIO) model, namely by embedding the econometric model into the input output model, using the 2016 based year, 52 economic sectors, and 22 data series from 2000 to 2021.*

*DIO is a hybrid model that places more emphasis on non-survey aspects that combines macro-econometric equations with identity equations in input-output analysis. This model has many dynamic equations consisting of 425 equation model. The parameters value of the equation are estimated using a combination of three estimation methods: (1) Ordinary Least Square, (2) First Order of Autoregressive, and (3) Second Order of Autoregressive. The general balance value in the DIO model is formulated using the Gauss-Seidel iteration "RAS" method.*

*The results of the study show that in 2024 the corporate services sector, the chemical, pharmaceutical and traditional medicine industry sector, and the transportation equipment industry sector are the dominant sectors in shaping changes in the structure of intermediate demand. The Construction Sector, the Corporate Services sector, and the transportation equipment industry sector are the dominant sectors shaping changes in the structure of intermediate input. The construction sector, the real estate sector, and the wholesale and retail trade sector, not cars and motorcycles, are the dominant sectors in shaping changes in the structure of final demand. For the gross value added component, the Wholesale and Retail Trade sector, Not Cars and Motorcycles, the Private Information and Communication sector, and the Financial*

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*Intermediary Services sector other than the Central Bank are the largest sectors in the formation of structural changes.*

*Keywords: Dynamic input output models, embedding, econometric models, input output models, Identity equation, structural changes.*

## I. Introduction

The regional input-output table (IO table) is a statistical chart designed by Wassily Leontief, which summarizes trade relations between industries in a region or a country. This table has been compiled in many countries around the world, as it can be used for a variety of analyzes and purposes to gain an understanding of the structure of the economy and determine the effects of certain economic impacts. However, regional IO tables cannot be used to analyze the impact of one region on another or vice versa. With the development of transportation infrastructure in the current modern era, the frequency of transactions between regions has become relatively high. Analyzing policy effects solely on the basis of inter-industry transactions that occur in a region has become very difficult.

Ainput output analysis is increasingly important in analyzing the economy of a region and between regions. This is shown by the many studies/research on the development of analysis IO table and interregional IO which have been actively carried out in recent years (Dietzenbacher et al., 2013b). Among other studies conducted in the State of Queensland in Australia (Trendle, 1999), for the Japans economy with 47 sectors (Ishikawa, 2004), and research for the Greece country's economy (Valma, 2014).

IO analysis has weaknesses compared to other analytical models (Guilhoto 2011). These weaknesses include: (1). The input coefficient or technical coefficient is assumed to be constant during the analysis or projection period, so that the technology used by economic sectors in their production process is also considered constant. As a result, changes in the quantity and price of inputs will always be proportional to changes in the quantity and prices of inputs; (2). Input output analysis is not able to explain the problem of income distribution in an economy because in that model there are no elements that can reflect income distribution; (3). Not being able to answer how to achieve the goals set in the most possible way when faced with certain resources.

Some of the weaknesses of input–output analysis, among others (BPS, 2021):

1. The input coefficient or technical coefficient is assumed to be constant during the analysis period. Because the technical coefficient is considered constant, the technology used by economic sectors in the production process is considered constant. As a result, changes in

the quantity and price of inputs will always be proportional to changes in the quantity and prices of output.

2. The input-output model requires relatively large costs in data collection and the availability of basic data is inadequate.

The fundamental weakness of the input-output theory is its static nature, so that input-output cannot make projections of future periods. While the reliability of a model is the ability of the model to estimate the economic conditions of a region in the future.

Großmann & Hohmann (2019), states that the input-output model is an analytical model related to the economy as a whole at a certain time, which shows the values of the flow of goods and services between different production sectors, especially the flow between industries. This analysis is based on the following assumptions:

1. The entire economy is divided into two sectors, namely the inter-industry sector and the final demand sector, both of which are capable of dividing into sub-sectors.

2. The total output of each industrial sector is generally able to be used as input by other sectors, the sector itself and by the final demand.

3. No two products are manufactured together. Each industry produces only one homogeneous product.

4. Prices, consumer demand, and factor supply are given.

5. There is a constant return to scale.

6. There is no external economy and production dyseconomy.

7. Input combinations are used in rigid fixed proportions. Input remains directly proportional to the level of output. This implies that there is no substitution between different materials and no technological progress. There is a fixed input coefficient of production.

Unlike the static input-output model (both closed and open), the dynamic model, for example, occurs when we relate the investment part of the final bill of goods to output. The dynamic input-output model expands the concept of inter-sectoral balance at a certain point in time as inter-sectoral balancing from time to time which also involves the concept of long-term capital. Leontief's dynamic input-output model is a generalization of the static model based on the same assumptions. As done by(West and Jackson, 1998);(Bolton, Jackson, and West, 1990); And(Fuentes and Pellégrini, 2021), where they integrate input-output models and dynamic systems with a variable approach to ecological economic systems. In such a system, the flow of material changes from one static state to another, depending on the difference between its current level and its equilibrium level.

Due to its complexity, the ecological economic system is an important factor, otherwise when this simulation is used there will be a big failure because it does not incorporate real functional processes, which can lead to failure in public policy.(Corider, Uehara, Weih, 2017; Limburg, O'Neil, Costanza, 2002; Uehara, Cordier, and Hamaide, 2018). There are at least two main sources of complexity: the first, the relationships between system elements that are not linear, predictable, or controllable. The second, the dynamics between elements that incorporate lag, throttling, boundaries and feedback loops(Dasgupta, 2003;Mäler, Xepapadeas, and de Zeeuw, 2003). Much literature states that the dynamic Input-Output model is different from other models because it simultaneously incorporates time variables and adjustment mechanisms that change investment or lag behind capital formation, resulting in an imbalance of the dynamic Input-Output model.

According to Fuentes and Pellégrini (2021), from the point of view of the aggregation process, the dynamic Input-Output model is more complete than the static input-output model, as it allows projection of the role of productive capital and sectors in the future, while considering not only the growth of final demand, but possibly also the formation of capital that required together with installed productive capacity constraints and sectoral disinvestment limits in generating growth.

Time series behavior is the result of applying the acceleration principle with the assumption that production and investment do not change immediately due to changes in final demand. Time wasted and mechanisms that are more flexible tend to result in better processes over relatively long periods of time. The input-output dynamic model is a useful tool for exploring development issues related to projected economic growth, how to speed up this process, and make it more efficient. In the dynamic IO model progress is reflected in terms of increasing average characteristics of the economic sector from year to year, including: productivity growth, reduction of technical coefficients (required input per unit of output), reduction of capital intensity etc.,(Dietzenbacher et al., 2013a; Aşkın, 2022; Hlongwane & Daw, 2021).

In the input-output approach, separate production of new and old equipment working side by side in the same year period, has been shown explicitly in the general equilibrium model based on the Cobb-Douglas function, see(Oberfield, 2018). But the Cobb-Douglas function assumes labor-capital substitution (i.e. any increase in one of these factors leads to an increase in output) which is not true. Meanwhile, Leontieff's model, on the other hand, considers the labor force as a strong restraint on growth, which under certain circumstances cannot be overcome by increasing one of the other factors. So explicitly, new technologies in the IO approach will substantially increase efficiency and overcome the drawbacks of the general equilibrium model mentioned above.

## II. DYNAMIC INPUT OUTPUT MODELS

Åberg and Persson (1981) have introduced a dynamic input-output model, with a uniform growth rate, to view and estimate the state of the economy over a long, limited, productive period of time and the rate of return on fixed capital acquired over a sufficiently long time, even in the case of reduced efficiency non-geometric. The latter model is the more general because it allows for a pattern of decreasing efficiency of capital equipment that persists over a long period of time.Lager (1997)have shown that the Aberg & Persson model is based on several assumptions, which appear to be a special case of the Sraffa-von Neumann version of the model.

Aulin and Ahmavaara (2000) construct a dynamic input-output model with long periods of productive fixed capital that include inventories. Different from the Johansen and Aberg & Persson models, this model does not observe a long period of utilization of capacity units, but looks at the length of the production period in producing its production units. In addition, replacements and net additions to internal capacity are required separately. In 1990 the Ulin-Ahmavaara model discussed and introduced a general model which includes the differences and similarities between the three models.

The relationship between demand and supply is described in Leontief's production function. The IO table shows the cost structure for each industry which is sourced from the demand for intermediate goods and the use of main inputs such as compensation for employees, depreciation, net taxes in the production process. Considering that the cost component is single, the price is reduced by using the cost per unit approach. The production price plus net taxes on the goods will determine the price at the purchase level, excluding disposable income. In contrast to the simple static IO model, the volume and price reactions in the macroeconometric IO model are empirically based and take into account shipping costs, thereby taking into account the level of competition in different product markets and labor markets.

Additional data is population by age group, labor and wages at the industry level. The population at working age determines the potential workforce. The demand for labor is determined by the level of labor productivity, the amount of production and the wages provided by the industry. An increase in real wages tends to reduce employment while a higher level of production will increase employment. Wage rates in macroeconomics are determined using the Phillips curve approach.

These conditions can be further described both through identity (eg in the context of IO) and empirically validated behavioral equations, and using econometric methods that allow imperfect markets and aspects of rationality to be aggregated(Yang et al., 2017). However, the model specification has never been completed with a single equation estimation so that a complete, and non-linear, equation system model is mutually required and solved iteratively for every year using the Gauss-Seidel algorithm. The iteration process is terminated after the given criteria are met.

This criterion should be an endogenously calculated model variable, such as output. As long as the models have not converged, all model equations are recalculated for the current year. Furthermore, all these equations are solved for the following years within a certain time range, as well as the form of the model that is created containing the code needed for algorithm iteration.

The exogenous drivers for this model are, for example, population growth and exports, which trigger adjustment reactions in the mutually necessary non-linear models. A modeling approach that includes not only quantity effects but also income and price effects, provides further multipliers that determine system dynamics, including:

1. Leontief multiplier: shows the direct and indirect effects of changes in demand (eg: consumption, investment), production;

2. Jobs and income multiplier: Increased production leads to more jobs and thus higher incomes result in higher demand (induced effect);

3. Investment accelerator: Indicates the investment required to maintain the capital stock required for production based on the demand for goods.

Dynamic IO models exist in various forms and degrees of complexity, for example in Eurostat (2008)(Eurostat, 2008; Stockers et al. (2011) inXing et al. 2017; Lehr et al. (2016) inXing et al. 2017;Uehara et al., 2018;Zheng et al. 2018;Großmann and Hohmann 2019; and Cambridge Econometrics-July et al. 2019). The preparation of the IO table can be done based on a bottom-up process and a top-down process. The bottom-up process shows that each product group for each industry is modeled individually and macroeconomic variables are calculated through explicit aggregation. The top-down process is carried out by determining the final demand component value at the macro level and then aggregated using the industry value or product share of each variable proportionally.

Seeing the benefits of a dynamic inter-industry input-output structure specification model with very high econometric modeling, many researchers are paying attention and developing integrated model designs, especially at the regional level, as shown by(Conway, 2022; Coomes, Olson, and Glennon, 1991; Hewings and Sonis, 2009; Israilevich et al.. 1997; LeSage and Magura, 1991; Rey, 2000; and Shao et al., 2017).

There are 2 (two) issues that are the focus of attention, first: the methodology with the specification of the input output model that is integrated with the econometric model; and second: to what extent the advantages of the inter-industry input-output structure can be flexibly and dynamically incorporated through an econometric (time series) modeling approach.

The input-output model emphasizes the inter-industry technology that determines the level of output and employment in a region. The development of the input-output model dates back to the early 1950s with the development of the input-output methodology by Leontief, Chenery and Moses. Many regional analysts turn to the input-output model to analyze the significant impact of inter-industry linkages on the local economy, as stated by(Kuenne, 1955; Miller, 1957; Richardson, 1985; Stevens et al., 1983), this model has gone through many stages of development, ranging from purely survey-based input-output models to non-survey techniques, as well as the development of impact analysis models in regional economic analysis. Examples of these models include the RIMS model(Watterson, 1985), model ADOMATR(Bahman Motii Norman 1998), the RSRI model(Pan and Richardson, 2015), and IMPLANT(Schreiner, Vargas, and Schreiner, 2020).

The input-output technique has expanded into more complex models(Batey, 2018). In this case a combination of input output and econometric estimation specifications, is often used as an estimation technique. The mechanism used generally uses estimates of final demand from econometric models as input for estimating input-output tables. As an example by(Kushnirsky, (1982); Bell, 1967; Crawley, Hewings, and Crawley, 2020; Richardson, 1985; Stevens et all., 1983), this mechanism suffers from the difficulty of constructing dynamic input-output table technical coefficients, which limits its usefulness for impact analysis and generally precludes its use as a forecasting tool.

On the other hand, econometrics as a subject is older than macro-econometric models, whose model development returns to its original function as Jan Tinbergen did for the Netherlands and the United States before the Second World War and continues to the present.(Kleins, 2003). Econometric models were originally nationally oriented and consisted of many equations designed to describe and predict the complete economic structure of countries. However, currently many macro-econometric models have been updated and have been developed and used in various fields and research.

Regional econometric models have evolved, as research has developed, and policy evaluation in regional economies as popular in the 1950s and 1960s(Glickman, 1979; Bolton et al., 1990;Pan and Richardson, 2015). Since the late 1960s, there has been growing interest among researchers to build a regional econometric model with a demand-side oriented Keynesian model. Many of these models are similar (at least in purpose) to some of the national econometric models developed from the Klein-Goldberger (1990) model.(Rey, 2000).

An econometric model is a set of equations which in some cases very simultaneously describe the structure of a regional economy, usually a country or a province or a metropolitan area. Equation parameters are estimated econometrically, mostly by regression equations. In contrast to the input-output model where the parameters are based on one-point observations. The usefulness of econometric models for development is clearly limited because no interactions are expressed among the variables (basic assumptions of econometrics) (Glickman, 1979).

Modeling systems based on input-output and econometrics can describe and represent the condition of an economy. This is very important in formulating economic development policies and further evaluation to consider the effects produced by the two systems in the economy. Beginning with the Philadelphia model compiled by Glickman in 1971, more and more studies have used the integration of input output and econometric models as stated by Duobinis (1981).(Masouman and Harvie, 2018). The same example is also shown by Lesage & Magura (1986) in (Masouman and Harvie, 2018; Glennon D., And Lane, J. Wagner, 1990); Moghadam & Ballard (1988) in (Coomes et al. 1991; Conway (1990) in Coomes et al., 1991; Glennon D., AndLane, J. Wagner 1990; LeSage and Magura, 1991; Israilevich et al., 1997; Treyz in Pan and Richardson, 2015; and Shao et al., 2017).

The integration between the input-output model and regional econometrics is built on the basis of the integration of the national model. In generalizing the form of integration, there are still methodological differences and the level of integration between one model and another. Although no standard classification has been introduced across the current integrated classification model, different classifications have been used at different times. Several actors have now adopted input-output models with integrated, embedded, modular, and composite econometrics as indicated by (Chowdhury 2000; Rey, West, and Janikas 2004), Kort & Cartwright (1981) in (Crawley et al. 2020) and Wegener (1986) in (Batey 2018).

Furthermore, these integrated models can be classified into three different groups of embedded formations, linkages, and composites Rey (1994) in (Crawley et al., 2020); Chowdhury (1984) in (Bahman Motii Norman, 1998), and Kort & Cartwright (1981) in (Rey, 2000).

For an approach with embedded model formation, a model (generally an input-output model) is embedded in another model (usually an econometric model) so as to form a comprehensive integrated model specification, so that the integrity of each model (input output or econometrics) can be carried out as stated by Moghadam & Ballard, (1988) in (Crawley et al., 2020). The embedding formation simultaneously produces input-output and econometric aspects in the intended model. On the other hand, linking and shaping use the output of one model as the input used by the other model.

In Indonesia, a new dynamic IO model was developed by several regional economics experts, such as the MIENA model (Indonesian Econometric Input Output Model) made by Brodjonegoro, PS. (1997) in Hendranata and Sinaga, 2004; and Rey, 2000, and MIOTRINA made by Anton H. (Hendranata and Sinaga 2004), and for the State of Oklahoma with the DIA (Dynamic Integration Approach) model developed by Bahman Motti Norman (Motii, 2005). The MIENA model developed by Bambang PS, (1997) is the Indonesian econometric input-output model in the singular form of 1997, while the MIOTRINA model developed by Anton H., (2007) is also the same as the Indonesian econometric input-output model in the singular form of 2005 and projections for 2010. The Dynamic Integration Approach (DIA) model developed by Brahman Motti Norman (1998) is a model that is almost the same as the MIENA and MIOTRINA models and is a single input-output dynamic model for the Oklahoma State region.

So the Dynamic Input Output (DIO) model is able to produce estimates of input-output tables in the future, especially the technology coefficient matrix (A). In this model, the price variable is fixed, considering that the time series data used is in the form of constant prices for 2016. Thus, price developments have no effect because they have been excluded from the data used. The DIO model treats the price factor as an exogenous variable (fixed variable) or in other words, the price is assumed to be fixed (fixed price). This results in the resulting input-output table still assuming price as a fixed factor.

## III. INTEGRATION CHANNELS BETWEEN INPUT-OUTPUT MODELS AND MACRO ECONOMETRIC MODELS

According to Chowdhury, the accounting relationship between inter-industry transactions, final demand, and factor payments along with the input-output balance equation can be used to construct a channel of integration between input-output and econometric models. This is an amalgamation of blocks in the interregional input-output table consisting of intermediate demand or intermediate input blocks, final demand blocks, total output blocks, primary input blocks (Gross Value Added), and total inputs (Chowdhury, 2000).

The intermediate demand block consists of blocks of imports and exports from and to regions within the economic area. Furthermore, the econometric model is a functional relationship between regional macro-econometric variables which describes the relationship of each block to other variables outside the IRIO system (such as the prices of factors of production, labor, investment and population, etc.).

The concentration of macro-econometric models in general is on the relationship between the final demand block (which represents the total expenditure on the macro-economic measurement side) and the factor payment block (which represents the total income side of the macro-economic measurement). On the other hand, the concentration of the input-output model in general is on the final demand block and the inter-industry transaction block (which represents demand and purchases). Figure ….. shows such a relationship, where Xij is the intermediate purchase of sector j (j=l.... n) of sector i (i=l.... n), fm is the final purchase of sector i for components m (m = C, I, G, EX = 1......m), and Ykj payments to sector k (k=l; k = labour, capital, rent, etc.) by sector.

Chowdhury (1984) argues that there is disharmony between the final demand categorization in the macro-econometric model (C, I, G. (XM)) and linking it to sector-based final demand in the IO model (C", I" ...). Therefore, if the relationship with the final demand I-0 can be linked to the aggregate demand component, then the impact of macro variable policies can be traced to the producing sector and income, so this mechanism will have a complete relationship. Thus both the Keynesian demand model and the Leontief I-0 system together can be formed with proper feedback between demand and supply.

More Important Integration Strategy is that the relationship between demand and supply can be easily established if time series data on sectoral final demand are available (Chowdhury, 2000). In this case, according Klein, (2003), final sector demand is treated as an endogenous function of the growth component of national expenditure in the macro-econometric model (Crawley et al., 2020). Choose one component for each sector which is assumed to be an endogenous variable, for example the assumption that aggregate spending is only limited to consumption and investment:

C, = C. (Yd) ……………………………………….(1)

I. = I, (Y) ………………………………………….(2)

C, and l are all elements of the final demand component matrix with n rows and m final demand categories. Cj is consumption demand for one output sector, and h is investment demand for one output sector. Y is GNP, and Yd is disposable income. In an alternative approach developed by Fisher, Klein, and Shinkai (1965), the final demand can be extracted from the basic input-output balance by providing time series data on sectoral gross output (Xj) (Crawley et al., 2020).

The input-output balance equation can be written as:

X = AX + F ……………………………………. (3)

Where X is the nxn matrix of total output, A is the nxn matrix of input-output technical coefficients, and F is the nx m final demand matrix. thus the F value in equation (7) is formulated as:

F = (IA) X ……………………..………………(4)

Equation (4) explains the final demand (Fj) of the total sectoral output (Xj). Once the final demand totals (Fj) are obtained, they can be linked to national spending blocks (eg C, I, etc). This can be done because Fj. in the national expenditure category. So that:

Fi = ϕi1 C + ϕi2 I + Ui ……………………………………(5)

In matrix form, it can be written as:

In other words;

Fi = ϕ11 C + ϕi2 I + u1 ………………………………(7)

F2 = ϕ21 C + ϕ22 I + u2 …………………………..(8)

Or this can be written as:

F = ϕ G + U…….…………………………….(9)

where ϕ is the nxm regression coefficient matrix for sector n and m components of aggregate demand, G is the mx 1 column vector of Gross National Expenditure, and U is the error term.

Having developed the relationship between G and F, we can now use the input-output balance equation to convert Gross National Expenditure to sectoral total output. That is:

$X = (IA)-1\ F = (IA)-1\ (\phi\ G+U) = (IA)-1\ \phi\ G + (IA)-1U$………….(10)

Considering that (X) is the estimate of total sectoral output, assuming the total added value of sectoral output is constant, then the estimated value added (value-added) can now be obtained, as follows:

$Y = BX$ …………………………………………(11)

where B is an nxn diagonal matrix with diagonal elements equal to $(1 - \sum aij)$, and of diagonal elements equal zero. In general, many of these methodological variations can be used to build integrated models. Its applicability depends on the specific situation in which the model is applied. For example, alternatives such as those related above apply if time series data for demand components at the sector level are available, where the coefficient matrix representing the proportion of each expenditure category (eg C) from all sectors can be known. Construction of sector final demand model (Fj) from total sectoral output, will be obtained if time series data of sectoral total output (Xj) is available.

## IV. GENERAL FRAMEWORK FOR INPUT-OUTPUT INTEGRATION AND MACRO ECONOMETRIC MODELS FOR THE PROVINCE OF DKI JAKARTA

Alternative integration methodologies as discussed earlier, can be summarized into a general integration strategy, which explicitly combines specific input-output relationships with econometrics. In this procedure the categories of national expenditure related to sectoral final demand and sectoral added value in the Input-Output table can be summarized as follows:

$Yj = Xj - (a11 + a12 + \ldots + aij)Xj = Xj - \sum aij\ Xj = (1-\sum aij)\ Xj$……..(12)

For i = 1, 2,.... n

This relationship can be expressed in matrix form:

$Y = BX$ …………………………………………..(13)

where Y is the matrix of nx 1 column vectors of sectoral added value, and B is the nxn matrix, where the diagonal elements of B can be expressed as:

$bij = 1 - \sum j\ aij$ for j = 1.2, s/dn ……………………(14)

Equation (13) is translated for X in terms of Y's added value, to be:

$X = B-1\ Y$ ……………………………………….(15)

Substitute equation (15) into the input-output balance equation (4), so that the value of F becomes:

F = (IA) B-1 Y …………………………………..(16)

Or:

F = DY ……………………………………………….(17)

Components A and B will determine that the D = (IA) B-1 matrix has an added value from each column. If not, then dij is a typical element of matrix D, so:

∑i dij = 1. for V j = 1,2,...... n ……………………………..(18)

Equation (20) describes the relationship between added value and final demand. We now need to show the relationship between final demand (F) and the components of national expenditure (C, I.G, XM). If we assume that each sector's production (fij) in the component of national expenditure (Gj) is a constant proportion (hij) of Gj then we can calculate the coefficient matrix (H) which describes the relationship between the component of national expenditure (NE) and sectoral final demand in IOs. So that:

hij, = fij / Gj is a constant, such that: ……….. (19)

∑ hij = 1 ………………………………………….(20)

so that the relationship between final demand and components of total national expenditure/GNE (G) will be:

Fi = ∑hij Gj ……………………………………………(21)

Or, assuming C and I are the only components of aggregate spending in a two-sector economy, then:

Where H is the nxm industry distribution of the final demand matrix, and G is mx 1 of the Total Government Expenditure (GNE) component matrix. Substituting equation (13) into equation (4) we get:

HG = (IA)B-1 Y ……………………………………. (23)

Now, in order to find Y and G (Components of National Expenditure Growth), we get:

Y = B(I - A)B-1 HG or ………………………………..(24)

Y = E.G

Based on the properties of D and H matrices, matrix E will be:

∑ eij = 1 for V i = 1, 2..... N. ……………………………..(25)

where eij are the elements of matrix E.

From this condition it is clear that:

$\sum Yi = \sum Gj$ ; where : i = 1 s/dn, and j = 1 s/dm …………………..(26)

Or

GNP = GNE ……………………………………….(27)

Based on the expenditure approach, the total value added by sector (National Production Growth) is equal to the total final demand. Given the technical coefficient matrix A, and the sectoral distribution of the final demand matrix H, a relationship can be made between the components of expenditure (G = C, I, etc.) with sectoral added value as Y = EG. These relationships together with the final demand model can build a macro model that will have a "full feedback" between supply and demand(Chowdhury 2000). Furthermore, some components of the final demand, which were initially treated as exogenous in the input-output model become endogenous for the system as defined in the macro-econometric model.(Rey et al., 2004).

4.1. Macro-Econometric Models of DKI Jakarta Region

1. Estimated value of total output :

Total Output is assumed to follow the cobb douglash production function where:

$Y^R_t = f(K^R_t, L^R_t)$ ……………………..………(28)
$Y^R_t = A (K^R_t)^{\beta 1} (L^R_t)^{\beta 2}$ ……………………………(29)
$\ln Y^R_t = \ln A + \beta_1 \ln K^R_t + \beta_2 \ln L^R_t + \varepsilon_t$ …………(30)
Where :
Y = Total Output
K = Capital
L = Labor
A, β = Parameters
R = regional - DKI Jakarta
t = year t
$\varepsilon_t$ = Standard Error

Total output is a function of Capital (capital) and Labor (Labor). Estimated number of workers for each sector, and each region. In this case the workforce in sector i and area j is a function of the regional minimum wage (UMR) in each province.

Estimation of the amount of capital (Capital) is carried out using a proxy for the amount of invested investment or gross fixed capital formation, which is a function of the national average interest rate, Total Gross Income both at the regional and national levels, total gross income of related sectors, value rupiah exchange rate against US$, and inflation rate.

Based on the estimated number of workers and the amount of capital, the estimated total output is a function of the amount of labor and the amount of capital, so that:

$Y^R_t = f(K^R_t, L^R_t)$ ………………………………………………………. (31)

$Ln\ Y^R_t = \beta_0 + \beta_1 \ln K^R_t + \beta_2 \ln L^R_t + \varepsilon_t$ ………………………….. (32)

Where β1 and β2 have values > 0; and β1 + β2 = 1.
The R regional employment equation is as follows:

$E^R_t = f\ (UMR^R_t)$ …………………………………… (33)

$E^R_t = \beta_0 + \beta_1\ UMR^R_t + \varepsilon_t$ ……………………….….. (34)

In natural logarithmic form as follows:

$LnE^w_t = \beta_0 + \beta_1\ lnUMR^R_t + \varepsilon_t$ ………………………….. (35)

Where :

$E^R_t$ = Number of workers in regional - DKI Jakarta in time period t.

$UMR^R_t$ = Regional minimum wage in regional - DKI Jakarta in time period t

β = Parameters

$\varepsilon_t$ = standard error

While the capital variable used is Investment which is the formation of gross fixed capital both at the national and regional levels. Investment function equation as follows:

$I^R_t = f(r_t$, Exchange Rate $US\$_t$, $Y/Cap^R$, $Y/Cap^N$, $GDP_t)$ ……(36)
$I^R_t = \beta_0 + \beta_1{}^r{}_t + \beta_2$ Exchange rate $US\$_t + \beta_3\ Y/Cap^R_t + \beta_4\ Y/Cap^N_t + \beta_5 GDP_t + \varepsilon_t$ ……………………………………………………(37)

In natural logarithmic form:

$\ln I^R_t = \beta_0 + \beta_1 \ln{}^r{}_t + \beta_2$ lnUS\$ exchange rate $_t + \beta_3\ lnY/Cap^R_t + \beta_4\ lnY/Cap^N_t + \beta_5\ lnGDP_t + \varepsilon_t$ ……………………………(38)

Where :

$I^R_t$ = Investment amount regional - DKI Jakarta in the time period t

$r_t$ = interest rate for time period t

KURS US\$ $_t$ = Rupiah exchange rate against US\$ in time period t

$Y/Cap^R_t$ = Regional income per capita Regional DKI Jakarta in time period t

$Y/Cap^N_t$ = National income per capita Indonesia in time period t

$GDP_t$ = GDP in time period t

β = parameters

εt = term error

2. Estimated final demand, including Public Consumption, Non-Governmental Institution Consumption, Government Consumption, Stock Changes, Gross Domestic Fixed Capital Formation (PMTDB), Exports and Imports, as follows:

a. Consumption estimation

Public consumption is a function of per capita income in a particular area, national per capita income, and the total population of people in the area, so that the functional form is as follows:

$CMasy^R_t = f\ (Y/Cap^R_t, Y/CapN_t, Pop^R_t,)$ ………………(39)
So that :
$Ln\ CMasy^R_t = \beta_0 + \beta_1 \ln Y/Cap^R_t + \beta_2 \ln Y/CapN_t + \beta_3 lnPop^R_t + \varepsilon_t$ ……………………………………(40)

Where :

| | |
|---|---|
| $CMasy^R_t$ | = Regional public consumption - DKI Jakarta in year t; |
| $Y/Cap^R_t$ | = Regional Income per capita - DKI Jakarta in the time period t |
| $Y/Cap^N_t$ | = National income per capita in time period t |
| $Pop^R_t$ | = Regional population - DKI Jakarta in time period t |
| $\beta$ | = parameters |
| $\varepsilon_t$ | = term error |

Consumption of Non-Governmental Institutions (CLNP) in a sector is a function of the total population of the area concerned, national, regional and national value added, and prices, so the functional form is as follows:

$CLNP^R_t = f(PDRB^R_t, Pop^R_t, PDB^N_t)$ ……………………….(41)

So that :

$\ln CLNP^R_t = \beta_0 + \beta_1 \ln PDRB^R_t, + \beta_2 \ln Pop^R_t + \beta_3 PDB^N_t + \varepsilon_t$ ……………………………………………….(42)

Government consumption is a function of the allocation of the government budget in the area, both from the central government and regional governments. So the functional form is as follows:

$CPmrth^R_t = f(APBD^R_t, APB^N_t)$ …………………………….(43)

So that :

$\ln CPmrth^R_t = \beta_0 + \beta_1 \ln APBD^R_t + \beta_2 \ln APBN_t + \varepsilon_t$ …………...(44)

Where :

| | |
|---|---|
| $CPmrth^R_t$ | = Government consumption inregional - DKI Jakartain year t; |
| $APBD^R_t$ | = Regional Revenue and Expenditure Budget inregional - DKI Jakarta in the time period t |
| $APBN_t$ | = National Revenue and Expenditure Budget in time period t |
| $\beta$ | = parameters |
| $\varepsilon_t$ | = term error |

b. Estimation of Investment

Total investment (Gross regional fixed capital formation) of a sector i in area j, is influenced by the interest rate, the rupiah exchange rate against the US$, gross income both at the national and regional levels in the previous year, the amount of the APBD/APBN, the disposable income of the previous year (Yd( t-1)) and population, with its functional form as follows:

$I^R_t = f(r_t, \text{US\$ exchange rate}_t, Y/Cap^R_t, Y/Cap^N_t, GDP_t)$ ………… (45)

$I^R_t = \beta_0 + \beta_1 r_t + \beta_2 \text{KURS US\$}_t + \beta_3 Y/Cap^R_t + \beta_4 Y/Cap^N_t + \beta_5 GDP_t + \varepsilon_t$ ……………………….(46)

In natural logarithmic form:

$\ln I^R_t = \beta_0 + \beta_1 r_t + \beta_2 \text{KURS US\$}_t + \beta_3 Y/Cap^R_t + \beta_4 Y/Cap^N_t + \beta_5 GDP_t + \varepsilon_t$ ……………………….(47)

Where :

| | |
|---|---|
| $I^R_t$ | = Regional Investment amount - DKI Jakarta in the time period t |
| $r_t$ | = interest rate for time period t |
| KURS $US\$_t$ | = Rupiah exchange rate against US$ in time period t |

| | |
|---|---|
| $Y/Cap^{R}_{t}$ | = Regional Income per capita - DKI Jakarta in the time period t |
| $Y/Cap^{N}_{t}$ | = National income per capita in time period t |
| $GDP_t$ | = GDP in time period t |
| $\beta$ | = parameters |
| $\varepsilon_t$ | = term error |

c. Estimates on exports

The export value of sector i in region j is influenced by the rupiah exchange rate against the US$, the total population of region j, NTB sector i, Y/stamp of the destination country (proxy), total gross income at both regional and national levels, inflation rate, and population. The functional form is as follows:

$Exp^{R}_{t} = f(KURS\ US\$_t, PDB^{N}_{t}, Y/Cap^{N}_{t}, r_t)$ ........................(48)

so that :

$\ln Exp^{R}_{t} = \beta_0 + \beta_1 \ln KURS\ US\$_t + \beta_2 \ln PDB_t + \beta_3 \ln Y/Cap^{N}_{t} + \beta_4 \ln(r)_t + \varepsilon_t$ ...........................(49)

Where :

| | |
|---|---|
| $Exp^{R}_{t}$ | = Regional exports - DKI Jakarta at time t |
| $KURS\ US\$_t$ | = Rupiah exchange rate against US$ in time period t |
| $PDB^{N}_{t}$ | = GDP in time period t |
| $Y/Cap^{N}_{t}$ | = National income per capita N in time period t |
| $r_t$ | = interest rate for time period t |
| $\beta$ | = parameters |
| $\varepsilon_t$ | = term error |

d. Estimation of imports

The import value of sector i in region j is influenced by the rupiah exchange rate against the US$, the total population of region j, NTB sector i, total gross income at both the regional and national levels, and the inflation rate, the functional form is as follows:

$Import^{R}_{t} = f(KURS\ US\$_t, Y/Cap^{R}_{t}, Y/Cap^{N}_{t}, r_t)$ ................(50)

So that :

$\ln Impor^{R}_{t} = \beta_0 + \beta_1 \ln KURSUS\$_t + \beta_2\ Y/Cap^{R}_{t} + \beta_3 \ln\ Y/Cap^{N}_{t} + \beta_4 \ln(r)_t + \varepsilon_t$ ...................(51)

Where :

| | |
|---|---|
| $Import^{R}_{t}$ | = Regional Import - DKI Jakarta at time t |
| $KURSUS\$_t$ | = Rupiah exchange rate against US$ in time period t |
| $Y/Cap^{R}_{t}$ | = Regional Income per capita - DKI Jakarta in the time period t |
| $Y/Cap^{N}_{t}$ | = National income per capita in time period t |
| $r_t$ | = interest rate for time period t |
| $\beta$ | = parameters |
| $\varepsilon_t$ | = term error |

e. Estimation of Inventory Changes

Inventory change estimation uses regression analysis of inventory change over time (t), using the best regression equation from several alternative existing regression equations (linear or non-linear in shape). This selection compares the estimated inventory change curve with respect to time, with the decision to use the largest calculated F-value.

3. Perform calculations on the Intermediate Input value. Where the number of inputs between sector i is the residual value of the Total Output of sector i after deducting the final demand (FD) of the sector, so that:

$TO^R_i = IA^R_i + FD^R_i$ ……………………………(52)

temporary :

$IA^R_i = TO^R_i - FD^R_i$ ……………………………(53)

Where :

$TO^R_i$ = Regional Total Output Sector i DKI Jakarta

$IA^R_i$ = Regional Intermediate Input ssector i DKI Jakarta

$FD^R_i$ = Regional Final Demand sector i DKI Jakarta

i = Sector 1 to 52

R = regional - DKI Jakarta

4. Based on the steps above, information is obtained related to the intermediate input component (intermediate output), final demand, and total output. Next, we build an approximate IO table, the balance value of which is carried out using the RA0S method. The results of the RA0S method form an IO table for a certain forecast year, which describes the interrelationships between sectors in an economy at the projected time.

5. Carry out further analysis to obtain the IO technology coefficient, and the final demand multiplier for the formation of output value in each sector in the estimated time period. Comparing the technological coefficients over time, and conducting an impact analysis of the forward linkage "Foreward Linkage", and the impact of the backward linkage "Backward Linkage", as well as an analysis of the follow-up impact according to the desired goals.

6. To see the effect of time changes in other projection years, it can be done by repeating the steps mentioned above, by entering projected values on the econometric variables that have been built, and pinning them back in the input output table. This allows us to see the impact of the development of exogenous variables on endogenous variables in the econometric model and its effect on the technological coefficients of the IRIO table and the relationship between sectors in an economy.

4.2. Data used

The data used in this study include:

1. Production amount data

2. Data on the number of the labor force

3. Data on the total population of DKI Jakarta

4. Data on the total population of Indonesia

5. Data DPRB DKI Jakarta

6. Data PDB Indonesia

7. Jakarta Demand Aggregate Data

8. Data on Bank Indonesia interest rate developments

9. Rupiah Exchange Rate Data against US$

10. Data on per capita income of DKI Jakarta and Indonesia

11. Total APBD and APBN Data

12. DKI Jakarta Community Consumption Data

13. Consumption Data of DKI Jakarta Non-Governmental Institutions

14. DKI Jakarta Government Consumption Data

15. DKI Jakarta Gross DOmestik Fixed Capital Formation Data

16. DKI Jakarta Inventory Change Data

17. DKI Jakarta Export Data

18. DKI Jakarta Import Data

19. And other related data.

Data used covers a period of 22 years, from 2000Th. to 2021Th., which is sourced from:

1. BPS DKI Jakarta (BPS DKI Jakarta 2021l2021i, 2021l, 2021k, 2021f, 2021h, 2021b, 2021a, 2021c, 2021j, 2021g, 2021d , 2021e)

2. BPS Republic of Indonesia (BPS RI 2021a, 2021b)

3. Bank Indonesia (Bank Indonesia 2021b, 2021a)

4. Ministry of Industry Republic of Indonesia

5. Ministry of Trade of the Republic of Indonesia (Ministry of Trade of the Republic of Indonesia 2021)

6. Ministry of Manpower of the Republic of Indonesia (Ministry of Manpower of the Republic of Indonesia 2021)

7. Ministry of Finance (Kementrian Keuangan RI 2021a, 2021b)

8. DKI Jakarta Provincial Bappeda

9. And other data sources are in accordance with the data needed in this study.

4.3. Framework for the preparation of DKI Jakarta Dynamic Input Output in 2024

So far, it is known that there are three methods in preparing the IO model, namely the direct survey method (which has been carried out, among others Richardson, 1972 in (Kronenberg, Fuchs, and Lexhagen 2018) ; Bulmer Thomas, 1982 in (Richardson 1985); Miller and Blair, 1985 in (Crawley et al. 2020), the non-survey method and the "readymade" technique (as done by Miller and Blair, 1985; Richardson, 1985; Schaffer & Chu, 1969; Smith and Morrison, 1974, Lahr, 1992; and Fleg et al., 1994–1995), as well as hybrid methods (as has been done by Schaffer, Laurent and Sutter, 1972; West 1996, Bomsma and Oosterhaven, 1992).

The preparation of the 2024 DKI Jakarta Provincial DIO model is based on the 2016 DKI Jakarta IO Transaction Table published by BPS DKI Jakarta, 2021. Based on the table, transactions between sectors, intermediate inputs, final demand, Total Output, intermediate inputs, primary inputs and total inputs can be determined on the basis of producer prices in 2016.

To determine the dynamic development of the said transaction, a macro-econometric model for DKI Jakarta was developed to project the components of aggregate demand and aggregate supply. This econometric model is embedded into the input-output model and the identity equation to obtain projections of the values of other components in the input-output table.

Based on the macro-econometric model, the projected value of the final demand component is obtained, which consists of public consumption, consumption of non-governmental organizations, government consumption, formation of gross domestic fixed capital, ending inventory, as well as the value of exports and imports, total output and primary inputs. With the identity equation in the input-output analysis, an intermediate input value (intermediate demand) can be obtained.

To develop a macro-econometric model for DKI Jakarta, the secondary data used is time series data from 2000 to 2021 (n=22) with the econometric model as shown in equations (28) to (53). Overall the model produced in DKI Jakarta Dynamic Input-Output is as follows:

**Table 1. DKI Jakarta Dynamic Input Output Model Structure**

| MODEL TYPE | SIMULTANEOUS, DYNAMIC, AND DUAL-LOG |
|---|---|
| Historical Data | 2000 - 2021 |
| Projection period | 2024 - 2030 |
| Number of sectors | 52 sectors |
| Elementary Year | Hong Kong 2016<br>(Using DKI Jakarta IO Table 2016, BPS, 2021) |

| Model Size (Quantity) | |
|---|---|
| exogenous variable | 21 |
| endogenous variable | 14 |
| Endogenous variable with lag | 4 |
| Behavioral equation | 435 |
| Identity equation | 156 |
| Macro Models | 8 Dynamic Models, 417 Behavior models, 417 identity equations |
| Production Equation (Total Output) | 53 (1 Dynamic Model, 52 behavioral models) |

Source: Data processed

In detail, the framework for developing the dynamic input output model for DKI Jakarta Province can be seen in Figure 1.

## V. CHANGES IN THE INPUT-OUTPUT STRUCTURE OF DKI JAKARTA IN 2016 AND 2024

Based on the procedures and stages of compiling the DIO (Dynamic Input Output) table with the method of embedding the econometric model into the input output model, as well as a combination of econometric equations and identity equations in the input output table analysis. By using the 2016 base year and 52 economic sectors, the DKI Jakarta Province input output table can be projected. For this reason, the DKI Jakarta Province Input Output Table Projection in 2024 can be produced with a 52x52 sector matrix dimension. The complete Projection Table for IO for DKI Jakarta Province in 2024 can be seen in the attachment. Based on the DKI Jakarta Province IO table in 2016 and its projections for 2024, it can be seen that there is a change in the structure of the input output table in appendix.

1. Intermediate demand structure

Changes in the demand structure between DKI Jakarta Province from 2016 to 2024 were highest in the corporate service sector with a total change of Rp. 371.44 T, followed by the chemical, pharmaceutical and traditional drug industry sectors with a total change of Rp. 187.97 T, the transportation equipment industry sector is Rp. 177.39 T. The sectors that have not changed are the seasonal and annual plantations; forestry and logging; Mining, coal and lignite; Metal ore mining; Mining and other quarrying; and the tobacco processing industry sector. Meanwhile, the sector that experienced a decline was the real estate sector; Other private services; Construction; Annual horticultural crops, annual horticulture and others; Provision of food and drink and the Livestock Sector with a value of – Rp. 63.09 T to Rp. 0.0001 million.

2. Intermediate input structure

The change in input structure between DKI Jakarta Province from 2016 to 2024 was highest in the construction sector with a total change of Rp. 515.43 T, followed by the Corporate Services sector with a total change of Rp. 179.06 T, the transportation equipment industry sector is Rp. 141.97 T. The sectors that have not changed are the seasonal and annual plantations; forestry and logging; Mining, coal and lignite; Metal ore mining; Mining and other quarrying; and the tobacco processing industry sector. Meanwhile, the sectors that experienced a decline were the private information and communication services sector; Wholesale and retail trade, not only cars and motorbikes; Insurance and pension funds; and the food crop agriculture sector with a value of - Rp. 60.2 T to Rp. 824.62 million.

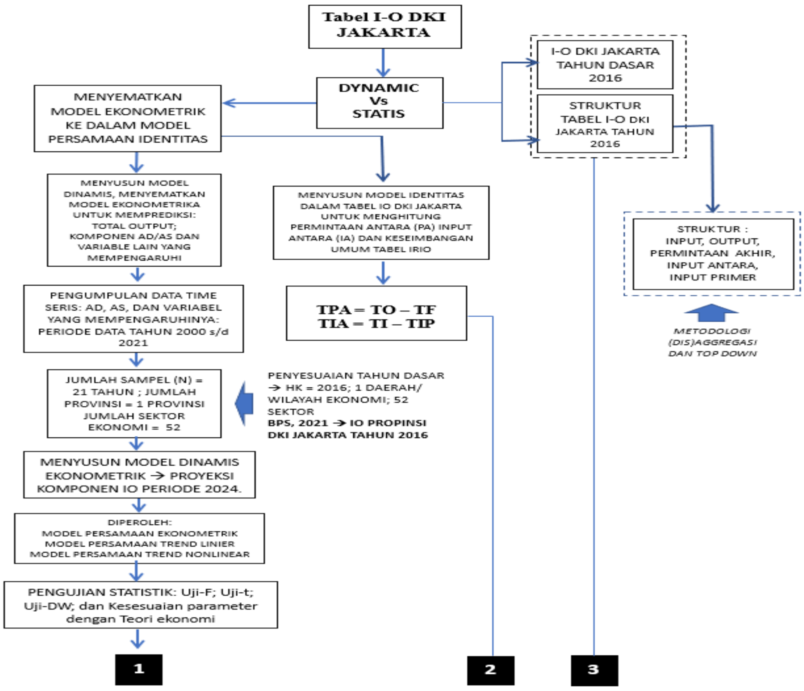
3. Final request structure

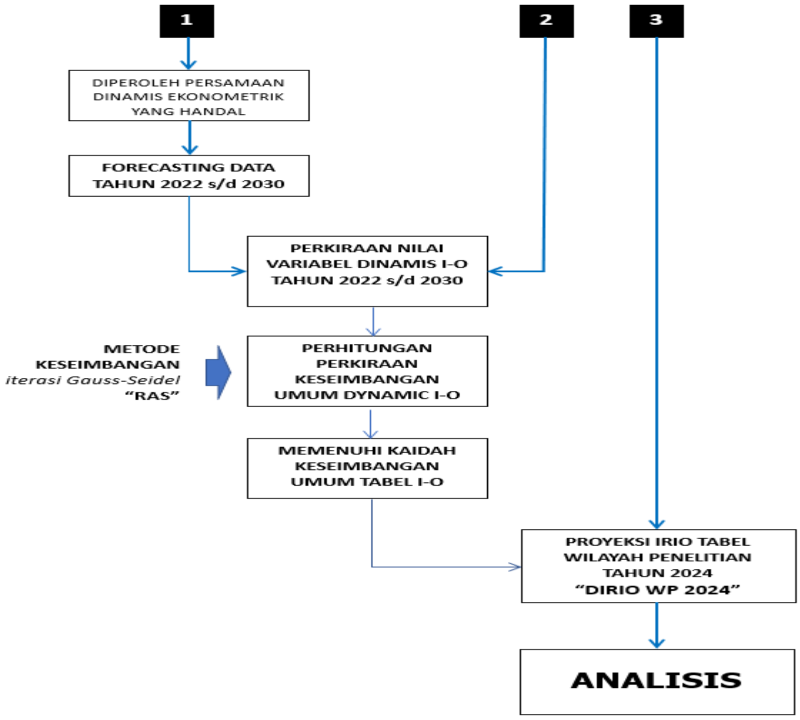
The change in the final demand structure for DKI Jakarta Province from 2016 to 2024 was highest in the construction sector with a total change of Rp. 449.14 T, followed by the real estate sector with a total change of Rp. 199.10 T, Wholesale and retail trade, not cars and motorbikes, Rp. 160.33 T. The sectors that have not changed are the seasonal and annual plantations; forestry and logging; Mining, coal and lignite; Metal ore mining; Mining and other quarrying; and the tobacco processing industry sector. Meanwhile, the sector that experienced a decline was the Corporate Services sector; Chemical, pharmaceutical and traditional medicine industries, metal and computer goods industry, electronic goods, optical and electrical equipment; basic metal industry to the river transportation sector, lakes and crossings with a value of – Rp. 83.64 T to Rp. 3.71 billion. Overall, there were 26 sectors that experienced a decline in the final demand structure, 6 sectors that remained stable, and 20 sectors that experienced an increase.

4. Structure of Gross Value Added

Changes in the structure of DKI Jakarta Province's Gross Added Value (NTB) from 2016 to 2024 were highest in the wholesale and retail trade sector, not cars and motorcycles with a total change of Rp. 249.29 T, followed by the private information and communication sector with a total change of Rp. 216.63 T, financial intermediary service sector other than the Central Bank with a total change of Rp. 130.13 T. The sectors that have not changed are the seasonal and annual plantations; forestry and logging; Mining, coal and lignite; Metal ore mining; Mining and other quarrying; and the tobacco processing industry sector. Meanwhile, the sector that experienced a decline was the construction sector; electricity; Metal and computer goods industry, electronic goods, optical and electrical equipment; basic metal industry sector; to the Livestock sector with a value of between - Rp. 70.94 T to 78.25 T. Overall there were 19 sectors that experienced a decrease in the gross value added structure, 6 sectors that remained constant, and 27 sectors that experienced an increase.

**Figure 1. Scheme for the development of the DKI Jakarta dynamic input output model, 2024**






5. Output and input structure

Changes in the structure of the DKI Jakarta Province Output/Input from 2016 to 2024 were highest in the Construction sector with a total change of Rp. 444.495 T, followed by the Corporate Services sector with a total change of Rp. 281.80 T, wholesale and retail trade sector, not cars and motorcycles with a total change of Rp. 218.83 T, and so on up to the food crop agriculture sector with a total change value of Rp. 16.6 billion. The sectors that have not changed are the seasonal and annual plantation sectors; forestry and logging; Mining, coal and lignite; Metal ore mining; Mining and other quarrying; and the tobacco processing industry sector. Meanwhile, the sector that experienced a decline was the construction sector; electricity; Metal and computer goods industry, electronic goods, optical and electrical apparatus; basic metal industry sector; to the Livestock sector with a value of between - Rp. 70.94 T to 78.25 T. Overall there were 46 sectors that experienced an increase in the total output/input structure, 6 sectors that remained the same, and no sector that experienced a decline.

Changes in transaction components in the DKI Jakarta Province Input-Output Table from 2016 to 2024 using the Dynamic Input Output (DIO) model produce the DKI Jakarta Province Input-Output Table with dimensions of 52 sectors x 52 sectors. Changes in the structure of the

Input-Output Table during 2016 and 2024 in DKI Jakarta Province can be seen in the Appendix.

## VI. CONCLUSION

Based on the 2016 DKI Jakarta Province Input Output Table, and using a dynamic models, through the process of embedding the econometric model into the input-output model, a projected input-output table for DKI Jakarta Province from 2022 to 2030 can be prepared. Based on these projections, the following conclusions can be drawn:

1. Projected input-output tables for the DKI Jakarta Province in 2024 can be generated using the input-output dynamic model by embedding the DKI Jakarta Province macro-econometric model into the input-output model. This dynamic model consists ofDynamic Models, 417 Behavior models, 416 identity equations.

2. There is a change in the component structure of the DKI Jakarta Province input output table from 2016 to 2024, both the structure of intermediate demand, final demand, intermediate input, primary input, and total output/total input. Changes in the demand structure between 2016 and 2024 consist of 6 sectors that have experienced a decrease in the final demand structure, 6 sectors that have remained constant, and 40 sectors that have experienced an increase. For the intermediate input structure, there are 4 sectors that have decreased, 6 sectors that have remained constant, and 42 sectors that have experienced an increase. The final demand structure consists of 26 sectors that have experienced a decline, 6 sectors that have remained constant, and 20 sectors that have experienced an increase. For the gross value added structure, there were 19 sectors that experienced a decline, 6 sectors that remained constant, and 27 sectors that experienced an increase.

3. If the Provincial Government of DKI Jakarta wants high final demand growth, it is necessary to pay attention to the development of the Construction sector, the Real Estate sector, and the Wholesale and Retail Trade sector, not Cars and Motorcycles, which are the 3 (three) sectors that have the highest role in forming demand end. On the other hand, if the Provincial Government of DKI Jakarta wants to create high gross added value, then it is necessary to pay attention to the development of the Wholesale and Retail Trade sector, Not Cars and Motorcycles, the Private Information and Communication sector, and the Financial Intermediary Services sector other than the Central Bank, which are sectors with the highest role in the formation of gross added value.

4. Given the limited data available, especially in terms of Aggregate Income and details, it is necessary to have a method of providing complete aggregate income component data every year. For this reason, it is suggested to data provider agencies, especially BPS, to develop a system for collecting and presenting the said data. To further improve the quality of the projection results, further research is suggested to place more emphasis on the reliability of macroeconomic concepts and behavior models, by adding endogenous variables that have a high influence on the projected value of regional macroeconomic variables.

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