No. 161 | January 1996 | Discussion Papers

Statistics Norway
Research Department

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**Abstract:**
An indicator of allocation effects of industrial policy is derived from a theoretical framework of monopolistic competition. The indicator gives a qualitative picture of how industrial policy affects industry structure and resource allocation, it identifies the policy measures that work as industry assistance under various assumptions about underlying parameters, and it allows a consistent comparison of the assistance effects of different measures. Indicator calculations of industrial policy represent an efficient alternative to numerical general equilibrium analyses, especially in international comparisons. Illustrative indicator calculations of Norwegian industrial policy are presented.

**Keywords:** Industry assistance, allocation effects, monopolistic competition, Norway.

**JEL classification:** F13, H25, L52

**Acknowledgement:** The author wishes to thank Erling Holmøy for stimulating discussions and helpful suggestions. I am also grateful to Ådne Cappelen, Finn R. Førsund, Leo Andreas Grünfeld and Tor Jakob Klette for comments on an earlier draft.

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# 1 Introduction

In most economies, a wide range of industrial policy measures are in use. To assess the allocation and welfare effects of such policies has been a major concern among economists, who frequently rely on computable general equilibrium (CGE) models. In spite of their obvious advantages, CGE studies of industrial policy have some drawbacks, too. First, to produce interesting results, a CGE model has to be rather disaggregated, forcing the model builder to identify a large number of substitution parameters important for the determination of allocation effects. The estimates of such parameters are often poor. Second, large scale CGE models are costly to construct. Third, in international comparisons of industrial policy, such as within the OECD, it is unlikely that one may agree upon a unified CGE framework. Given these drawbacks, it may be fruitful to provide information about the allocation effects of industrial policy by means of less sophisticated measures. One alternative, which I will concentrate on in this paper, is to develop *indicators* of government assistance. That is, from theoretical foundations, to construct summary measures of how a wide range of industrial policy measures affect resource allocation. An indicator should transform various policy measures so that they can be compared and added together, with weights corresponding to their allocation effects. An indicator is not intended to give accurate predictions of the allocation effects of government policy, but rather to give qualitative *indications*. To justify this loss of accuracy, an indicator should be simple to calculate, requiring knowledge of only a small set of parameters.

Existing indicators designed to measure the allocative or welfare effects of government policies, such as the Trade Restrictiveness Index (TRI), see Anderson, Bannister and Neary (1995) and the Effective Rates of Assistance (ERA) indicator, see Corden (1966) or Holmøy and Hægeland (1995), are all based on the small open economy assumptions - constant returns to scale, homogeneous products and exogenous world prices. Such assumptions are restrictive but convenient, since they facilitate a separation of the demand and supply side of the economy. This separability implies that resource allocation is determined independently of the structure of demand, and thus greatly simplifies the construction of indicators. During the last two decades, the «new theory of international trade» has emerged as a complement to differences in technology and factor endowments in explaining resource allocation and international trade. The innovations of the new theory rest on the idea that there exist industries producing differentiated products, that in every country there is demand for a wide range of varieties of each product, and that varieties are produced by means of a technology with increasing returns to scale. A pioneering reference is Krugman (1979), who developed a one-industry model with increasing returns and monopolistic competition able to explain intra-industry trade. Helpman (1981) provided a generalisation of the Heckscher-Ohlin-Samuelson theory, including industries with increasing returns and monopolistic competition. Common to most of the theoretical multi-industry models of international trade and resource allocation within this «new» framework, is that there is one homogeneous goods industry and one industry producing differentiated varieties. The model presented in this paper is in part inspired by Flam and Helpman (1987), who also studied the effects of industrial policy under monopolistic competition. However, there are several important differences. While Flam and Helpmans model contained only one differentiated goods industry and one homogeneous goods industry, the model presented here contains several differentiated goods industries in addition to an industry producing homogeneous capital associated with the firms' fixed costs. Moreover, Flam and Helpman associated the fixed costs with product development, while the fixed costs in this model come from plant investments that are independent of the level of production. In Flam and Helpmans model, no varieties are invented ex ante, while I assume that there is an infinite number of producable varieties and no development costs. Due to the assumption regarding what constitutes fixed costs, it is irrelevant whether varieties are «new» or «old», since all firms within an industry incur the same fixed costs. Within this framework, I study the effects of tariffs, export subsidies, commodity taxes, production subsidies and commodity taxes and subsidies on capital equipment. It is shown that it is possible to derive a consistent indicator of the allocation effects of industrial policy, which also accounts for general equilibrium effects. In order to apply the indicator empirically, knowledge of only a small set of parameters is required.

Section 2 of this paper presents the theoretical framework. In section 3 the industrial policy indicator is developed. In the case of two consumption goods industries and two primary factors it is shown that, when income effects are ignored, there exists a monotonic relation between changes in the appropriate policy indicator and the relative changes of aggregate industry production. Several special cases are considered, and it is shown e.g. that the Heckscher-Ohlin-Samuelson (HOS) model - and hence a simple form of the ERA indicator - appears as a limiting case of the model. In section 4 the results of some tentative indicator calculations of Norwegian industrial policy are presented and briefly discussed. Section 5 offers some concluding remarks.

## 2 Theoretical Framework

The available consumption goods can be naturally divided into n different groups, called *products*. The *varieties* of each product share some common characteristics, but are viewed as heterogeneous. The utility function of a representative individual has the form:

$$(1)\quad U = \prod_{i=1}^{n} u_i^{\alpha_i}\ , \qquad \sum_{i=1}^{n} \alpha_i = 1$$

The $u_i$'s are the subutility levels from consumption of varieties of the different products. The subutility functions, as introduced by Dixit and Stiglitz (1977), have constant elasticities of substitution. We distinguish between varieties of domestic and foreign origin.

$$(2)\ u_i = \left[\sum_{j=1}^{a_i} d_{ihj}^{1-1/\sigma_i} + \sum_{g=1}^{b_i} d_{ifg}^{1-1/\sigma_i}\right]^{\frac{1}{1-1/\sigma_i}} \quad i = 1,\ldots\ldots,n$$

$a_i$ is the available number of domestically produced varieties, while $b_i$ is the number of imported varieties. $d_{ihj}$ is demand for variety j of the domestically produced varieties of product i, while $d_{ifg}$ is the corresponding for imported varieties. $\sigma_i$ is the elasticity of substitution between varieties of product i, and is assumed to be greater than 1 for all i. This structure of preferences yields the following demand functions:

$$(3)\ d_{ihj} = \frac{p_{ihj}^{-\sigma_i}}{(1+v_i)\left[\sum_{j=1}^{a_i} p_{ihj}^{1-\sigma_i} + \sum_{g=1}^{b_i}\left(p_{ifg}(1+t_i)\right)^{1-\sigma_i}\right]}\alpha_i E\ , \qquad i = 1,\ldots\ldots,n \qquad j = 1,\ldots\ldots,a_i$$

$$(4)\ d_{ifg} = \frac{\left(p_{ifg}(1+t_i)\right)^{-\sigma_i}}{(1+v_i)\left[\sum_{j=1}^{a_i} p_{ihj}^{1-\sigma_i} + \sum_{g=1}^{b_i}\left(p_{ifg}(1+t_i)\right)^{1-\sigma_i}\right]}\alpha_i E\ , \qquad i = 1,\ldots\ldots,n \qquad g = 1,\ldots\ldots,b_i$$

$$(5)\ d_{ihj}^{*} = \frac{(1+e_i)p_{ihj}^{*\ -\sigma_i}}{\sum_{j=1}^{a_j} p_{ihj}^{*\ 1-\sigma_i} + \sum_{g=1}^{b_k}\left(p_{ifg}^{*}(1+e_i)\right)^{1-\sigma_i}}\alpha_i^{*} E^{*}\ , \qquad i = 1,\ldots\ldots,n \qquad j = 1,\ldots\ldots,a_i$$

p is the producer price, $t_i$ is the tariff rate, $v_i$ is the commodity tax rate and $e_i$ is the export subsidy rate. E denotes consumer expenditure. Asterisks denote magnitudes relating to the foreign market. Hence, $d_{ihj}^{*}$ is demand abroad for the domestically produced variety j of product i.

In the following discussion, firms producing varieties of the same product will be regarded as an *industry*. Thus there are n final goods industries. We assume that there exists an infinite number of producable varieties of each product. There are no development costs, and hence no cost advantages of imitation. There are no differences in costs of producing different varieties of a product. With the symmetric structure of preferences described above, a profit-maximising firm considering entry will choose a variety that is not manufactured by other firms. The producers incur fixed costs from capital equipment necessary for production. If a firm closes down, the capital equipment may be sold. Once installed, the service flow from the capital equipment can be varied costlessly. It is assumed that these services are not a factor of substitution, but vary proportionally with the level of production. When all production factors may be varied, the technology is assumed to be linearly homogeneous. Since one of the factors (capital services) is free on the margin, this implies decreasing average costs. The firms within an industry are assumed to be homogeneous with respect to productivity. (Holmøy (1996) discusses the properties of a similar model when firms differ in productivity.) To be able to derive an indicator, intermediate inputs must be disregarded. This has the obvious consequence that the indicator will not capture effects via price changes of intermediates, but on the other hand, inclusion of intermediates into this framework would make the construction of an indicator impossible. The profit maximisation problem of a representative firm is:

$$(6)\quad \pi_i = \max_{p_i} \left\{ p_i\, x_i(p_i) - \eta_i p^K (1+v_i^K)\overline{K}_i - \frac{c_i(\mathbf{w})}{1+s_i} x_i(p_i) \right\} \qquad i = 1,\ldots\ldots,n$$

where $\mathbf{w}$ is a vector of factor prices, $\eta_i$ is the per krone user cost of capital equipment, $p^K$ is the net-of-tax price per unit of capital equipment and $v_i^K$ is the industry-specific tax on capital equipment purchases. $\overline{K}_i$ is the (industry-specific) capital equipment requirement per firm.

We assume that there are many active firms (available varieties) within each industry, so that the own-price elasticity of demand is close to $-\sigma_i$. As is common in the literature, producers are assumed to ignore the effect of their own price on the price index. This gives the following pricing rule:

$$(7)\quad p_i = \left(\frac{\sigma_i}{\sigma_i - 1}\right)\left(\frac{c_i(\mathbf{w})}{1+s_i}\right) \qquad i = 1,\ldots\ldots,n$$

Since both variable costs and the elasticity of substitution are equal for all varieties within a commodity group, all domestically produced varieties within a commodity group have the same price and are manufactured in the same quantity. The equilibrium level of production is:

$$(8)\ x_i = d_{ih} + d_{ih}^* = \frac{p_{ih}^{-\sigma_i}}{(1+v_i)\left[a_i p_{ih}^{1-\sigma_i} + b_i^*\left[p_{ih}^*(1+t_i)\right]^{1-\sigma_i}\right]}\alpha_i E + \frac{p_{ih}^{-\sigma_i}}{\frac{1}{1+e_i}\left[a_i p_{ih}^{1-\sigma_i} + b_i^*\left[p_{ih}^*(1+e_i)\right]^{1-\sigma_i}\right]}\alpha_i^* E^*$$

We assume free entry and exit of firms. Entry-exit equilibrium implies zero profits in all firms. The model then corresponds to what is known as «Chamberlins Large Group Case» (cf. Chamberlin (1933)). It is assumed that the entry-exit equilibrium is stable, i.e. entry of firms causes declining profits per firm. The zero profit condition implies:

$$(9)\ x_i = \frac{\eta_i p^K(1+v_i^K)\overline{K}_i(1+s_i)}{c_i(\mathbf{w})}(\sigma_i - 1)$$

Aggregate industry production is defined as:

$$(10)\ X_i = a_i x_i$$

New capital equipment is produced by the construction industry at constant unit costs, $\overline{c}_K(w)$. Capital equipment is assumed to be homogeneous between industries. This means that it can be reallocated from one industry to another without any adjustment or installation costs. An entering firm may buy its capital equipment either from a firm closing down in another industry or from the construction industry. The construction industry will only be active as long as the cost of producing one unit of capital equipment does not exceed the price, that is $\overline{c}_K(\mathbf{w}) \leq p_K$. When all differentiated products industries are in entry-exit equilibrium, the construction sector is active, but is only supplying the need for replacement investments. We assume that this production requires only a negligible fraction of the available primary factors. A similar assumption is made by Gavin (1990). Letting $s^K$ denote subsidies on capital equipment, competition in the construction industry is assumed to ensure:

$$(11)\frac{\overline{c}_K(\mathbf{w})}{1+s^K} = p_K$$

In the reasoning above, it is assumed that capital equipment is a homogeneous good. It would probably be more realistic to regard capital equipment as industry specific, but rebuildable. This is discussed within a HOS-type model by Mussa (1978), where a rebuilding industry is adjusting «second-hand» capital equipment from one industry for use in other industries. Increasing marginal costs in the rebuilding industry slows the reallocation of capital, but the stationary equilibrium is the same as if such rebuilding costs were absent.

The equilibrium conditions in the factor markets complete the model:

$$(12)\ V_l = \sum_{i=1}^{n} a_i x_i c_{il}(\mathbf{w}),\ l=1,\ldots,k$$

$V_l$ is the available quantity of factor l, while $c_{il}(\mathbf{w})$ is the unit demand for factor l in industry i.

Aggregate consumer expenditure, E, is equal to total factor remuneration plus net government transfers. We assume that government transfers are adjusted endogenously, such that consumer expenditure is constant. This implies that neither the government budget nor trade necessarily is balanced. Neglecting income effects is done in order to simplify the analysis, thereby focusing on direct allocation effects only. The model consists of (7), (8), (9), (10), (11) and (12), which are 4n+k+1 equations determining $x_i$, $p_i$, $a_i$, $X_i$, $w_l$ and $p^K$.

What formally distinguishes this model from the traditional HOS model, is the existence of fixed costs and that the elasticities of demand take on finite values. From (7) and (8), note that $x_i$ can be expressed as a function of $\mathbf{w}$ and $a_i$ ($x_i = f_i(a_i, \mathbf{w})$). (9) and (12) may then be written:

$$(9')\ \eta_i\left(1+v_i^K\right)\frac{\overline{c}_K(\mathbf{w})}{1+s^K}\overline{K} = \frac{1}{\sigma_i - 1}\frac{c_i(\mathbf{w})}{1+s_i}f_i(a_i, \mathbf{w}),\ i=1,\ldots\ldots,n$$

$$(12')\ V_l = \sum_{i=1}^{n} a_i f_i\left(a_i, w\right)_i c_{il}(w),\ l=1,\ldots,k$$

In the HOS model, factor prices are determined recursively in a system of equations similar to (9´). Production in each industry then follows from the factor market equilibrium conditions. In this model, however, it is somewhat more complicated. Because of the existence of fixed costs, the number of firms is important, while it is indeterminate and without any interest in the HOS model. Since the number of firms appears in (9´), the recursivity between factor prices and production is lost.

# 3 An indicator of industrial policy

In this section the effects of the specified industrial policy measures are derived. The reference point is a situation where no policy measures are active. We define an industrial policy variable, which is shown to be a relevant indicator of the effects of government assistance on resource allocation the different measures contained in this model when considering a case with two primary factors and two industries in addition to the construction industry (denoted as the «(2+1)x2»-case). Since we are primarily interested in resource allocation, the effects on the number of varieties (firms) within each industry and production per firm are not presented, thus neglecting welfare considerations.

Define:

$\theta_i^H = \dfrac{a_i p_i x_i}{\alpha_i E + \alpha_i^* E^*}$ , domestic producers' share of total production in industry i.

$\phi_i^H = \dfrac{\alpha_i E}{\alpha_i E + \alpha_i^* E^*}$, domestic market's share of total demand.

Letting $\bar{s}$ denote (1+s) and $\hat{x}$ denote relative change in x, differentiation of (8) yields:

$$(13)\ \hat{x}_i = \left[-\sigma_i + \theta_i^H(\sigma_i - 1)\right]\hat{p}_i - \theta_i^H \hat{a}_i - \phi_i^H \hat{\bar{v}}_i + \left[\left(1-\phi_i^H\right)\left(\sigma_i - \theta_i^H(\sigma_i - 1)\right)\right]\hat{\bar{e}}_i + \phi_i^H\left(1-\theta_i^H\right)(\sigma_i - 1)\hat{\bar{t}}_i$$

The coefficient for $\hat{p}_i$ is the pari passu own-price elasticity of demand, i.e. when all domestic producers change their prices simultaneously. The second term reflects that a relative change in the number of domestic firms will have greater impact on demand for a specific variety the larger the share of domestic production. Commodity taxation reduces demand proportionally to the relative size of the domestic market, as captured by the third term. The coefficients for export subsidies and tariffs are the pari passu own-price and cross-price elasticities respectively, weighted with market shares. Differentiation of the pricing equation (7) yields:

$$(14)\ \hat{p}_i = \sum_{l=1}^{k} \theta_{il}\hat{w}_l - \hat{\bar{s}}_i,\ i = 1,\ldots,n$$

where $\theta_{il} = c_{il}(\mathbf{w})w_l / c_i(\mathbf{w})$, production factor l's share of variable costs in industry i. After some rearrangements, differentiation of the zero-profit condition (10) yields:

$$(15)\ \sum_{l=1}^{k}(\theta_{il}-\theta_{Kl})\hat{w}_l + \hat{x}_i = \hat{v}_{Ki} - \hat{s}_K + \hat{s}_i\ ,\ i = 1,\dots\dots,n$$

From the factor market equilibrium conditions one gets:

$$(16)\ \sum_{i=1}^{n}\lambda_{li}\left[\hat{a}_i + \hat{x}_i + \varepsilon_l^i\hat{w}\right] = \sum_{i=1}^{n}\lambda_{li}\left[\hat{X}_i + \varepsilon_l^i\hat{w}\right] = 0\ ,\ i = 1,\dots.,n$$

where $\lambda_{li} = c_{il}a_i x_i / V_l$ is the share of factor l that is employed in industry i. $\varepsilon_l^i$ is a vector of conditional demand elasticities for factor l in industry i with respect to factor prices. Inserting (14) in (13) using (7):

$$(17)\ \hat{X}_i - (1-\theta_i^H)\hat{a}_i = \left[-\sigma_i + \theta_i^H(\sigma_i - 1)\right]\left(\sum_{l=1}^{k}\theta_{il}\hat{w}_l - \hat{s}_i\right) - \phi_i^H\hat{v}_i + \left[(1-\phi_i^H)(\sigma_i - \theta_i^H(\sigma_i - 1))\right]\hat{e}_i + \phi_i^H(1-\theta_i^H)(\sigma_i - 1)\hat{t}_i$$

From (15) and (9), one can find an expression for $\hat{a}_i$, which in turn is inserted in (17). Rearrangement gives:

$$(18)\ \theta_i^H\hat{X}_i + \sum_{l=1}^{k}\left[\theta_{il}\left((\sigma_i - 1)(1-\theta_i^H) + \theta_i^H\right) + \theta_{Kl}(1-\theta_i^H)\right]\hat{w}_l = \hat{N}_i\ \ ,\ i = 1,\dots\dots.,n$$

where $\hat{N}_i$ is an industrial policy variable:

$$\hat{N}_i \equiv \left(\sigma_i - \theta_i^H(\sigma_i - 1) - (1-\theta_i^H)\right)\hat{s}_i + (1-\phi_i^H)(\sigma_i - \theta_i^H(\sigma_i - 1))\hat{e}_i + \phi_i^H(1-\theta_i^H)(\sigma_i - 1)\hat{t}_i - \phi_i^H\hat{v}_i + (1-\theta_i^H)(\hat{s}_K - \hat{v}_{Ki})$$

$$\frac{\partial N_i}{\partial s_i} > 0,\ \frac{\partial N_i}{\partial e_i} > 0,\ \frac{\partial N_i}{\partial t_i} > 0\ \ \frac{\partial N_i}{\partial v_i} < 0,\ \frac{\partial N_i}{\partial s_K} > 0,\ \frac{\partial N_i}{\partial v_{Ki}} < 0$$

As seen from (18), $\hat{N}_i$ represents all partial equilibrium effects on aggregate industry production of the policy measures considered in this study. The weights of the different measures in $\hat{N}_i$ are dependent on the size of the elasticity of substitution, domestic producers' share of total production and the domestic market's share of total demand. The coefficient for production subsidies is equal to the absolute value of the pari passu own-price elasticity of demand minus the term $(1-\theta_i^H)$. This term comes from the zero-profit condition. Subsidies increase production per firm in partial equilibrium, whereas tariffs, export subsidies and commodity taxes do not appear in the zero profit condition. Therefore optimal production per firm does not change (in partial equilibrium) due to changes in these policy parameters. Changes in aggregate industry production take place through entry or exit of firms. The coefficient in the export subsidies' term is equal to the pari passu own-price elasticity of demand times the initial export share of domestic production, while the coefficient in the tariff term is equal to the pari-passu cross-price elasticity times the home market share of demand. Subsidies and taxes on capital appear in the last term of the industrial policy variable. Subsidies to capital induce entry and reduce equilibrium production per firm. The effect is larger the smaller the initial domestic share of production. This is because a new entrant reduces the demand towards all existing firms, both domestic and foreign, within the industry. When the initial domestic share of production is small, a new domestic firm captures more demand from foreign than domestic firms, thereby increasing domestic aggregate industry production, everything else given.

We will now investigate, in the «(2+1)x2»-case, whether $\hat{N}_i$ is a relevant indicator of allocation effects of government policy measures when general equilibrium interactions through factor prices are taken into consideration. Rearranging (16) gives the following expressions

(19a) $\hat{X}_1 = \gamma_1(\hat{w}_1 - \hat{w}_2)$

(19b) $\hat{X}_2 = \gamma_2(\hat{w}_2 - \hat{w}_1)$

where

$$\gamma_1 = \frac{\lambda_{12}\varepsilon_{21} + \lambda_{22}\varepsilon_{12}}{\lambda_{11} - \lambda_{21}}, \quad \gamma_2 = \frac{\lambda_{21}\varepsilon_{12} + \lambda_{11}\varepsilon_{21}}{\lambda_{11} - \lambda_{21}}$$

$\varepsilon_{ef} = \lambda_{e1}\varepsilon_{ef}^1 + \lambda_{e2}\varepsilon_{ef}^2$, are the average cross-price conditional elasticities, which are both non-negative in a two-factor system. Thus, the numerators in $\gamma_1$ and $\gamma_2$ reflect the aggregate substitution possibilities in the economy. Ordering the industries so that industry 1 is relatively intensive in the use of factor 1, the $\gamma$'s are non-negative, and strictly positive as long as there are any substitution possibilities between the two primary factors in at least one industry. (19a) and (19b) shows that the link between relative factor prices and total production in the respective industries is essentially the same in this model as in the traditional HOS model: If the price of a primary factor increases, the industry that employs this factor most intensively expands its aggregate production. The other industry contracts. The reallocations are larger the greater the substitution possibilities between the primary factors. However, a major difference from the HOS model is that the factor prices are determined simultaneously with the level of production.

It remains to investigate the relation between changes in the industrial policy variable and changes in relative factor prices. In the «(2+1)x2»- case (18) may be written:

$$\text{(18' a)}\quad \theta_1^H\hat{X}_1+\left(\theta_{11}\left((\sigma_1-1)(1-\theta_1^H)+\theta_1^H\right)+\theta_{K1}(1-\theta_1^H)\right)\hat{w}_1+\left(\theta_{12}\left((\sigma_1-1)(1-\theta_1^H)+\theta_1^H\right)+\theta_{K2}(1-\theta_1^H)\right)\hat{w}_2=\hat{N}_1$$

$$\text{(18' b)}\quad \theta_2^H\hat{X}_2+\left(\theta_{21}\left((\sigma_2-1)(1-\theta_2^H)+\theta_2^H\right)+\theta_{K2}(1-\theta_2^H)\right)\hat{w}_1+\left(\theta_{22}\left((\sigma_2-1)(1-\theta_2^H)+\theta_2^H\right)+\theta_{K2}(1-\theta_2^H)\right)\hat{w}_2=\hat{N}_1$$

(18'a), (18'b), (19a) and (19b) are four independent equations determining $\hat{w}_1$, $\hat{w}_2$, $\hat{X}_1$ and $\hat{X}_2$ as functions of $\hat{N}_1$ and $\hat{N}_2$. After some rearrangements, (19a) and (19b) inserted in (18'a) and (18'b) respectively yield:

$$\text{(20)}\quad \left(\gamma_1+\frac{\theta_{11}\left((\sigma_1-1)(1-\theta_1^H)+\theta_1^H\right)+\theta_{K1}(1-\theta_1^H)}{\theta_1^H}\right)\hat{w}_1+\left(\frac{\theta_{12}\left((\sigma_1-1)(1-\theta_1^H)+\theta_1^H\right)+\theta_{K2}(1-\theta_1^H)}{\theta_1^H}-\gamma_1\right)\hat{w}_2=\frac{1}{\theta_1^H}\hat{N}_1$$

$$\text{(21)}\quad \left(\frac{\theta_{21}\left((\sigma_2-1)(1-\theta_2^H)+\theta_2^H\right)+\theta_{K1}(1-\theta_2^H)}{\theta_2^H}-\gamma_2\right)\hat{w}_1+\left(\gamma_2+\frac{\theta_{22}\left((\sigma_2-1)(1-\theta_2^H)+\theta_2^H\right)+\theta_{K2}(1-\theta_2^H)}{\theta_2^H}\right)\hat{w}_2=\frac{1}{\theta_2^H}\hat{N}_2$$

The determinant of the equation system (20) and (21) is equal to:

$$\gamma_1\left(\frac{\sigma_2(1-\theta_2^H)+\theta_2^H}{\theta_2^H}\right)+\gamma_2\left(\frac{\sigma_1(1-\theta_1^H)+\theta_1^H}{\theta_1^H}\right)+\frac{A}{\theta_1^H\theta_2^H}$$

where

$$\begin{aligned}A=&(\theta_{11}-\theta_{21})\left((\sigma_1-1)(1-\theta_1^H)+\theta_1^H\right)\left((\sigma_2-1)(1-\theta_2^H)+\theta_2^H\right)+(\theta_{11}-\theta_{K1})\left((\sigma_1-1)(1-\theta_1^H)+\theta_1^H\right)(1-\theta_2^H)\\&+(\theta_{22}-\theta_{K2})\left((\sigma_2-1)(1-\theta_2^H)+\theta_2^H\right)(1-\theta_1^H)\end{aligned}$$

Both the first two terms of the determinant are strictly positive, provided there are substitution possibilities in at least one industry. It remains to investigate the sign of A. Given the assumptions about factor intensities made earlier, the first term in the above expression is positive. One of the last two terms may be negative, however. This will be the case if the factor intensities in the capital equipment industry are «extreme», so that either $\theta_{11} < \theta_{K1}$ or $\theta_{22} < \theta_{K2}$. (Note that both inequalities cannot be fulfilled simultaneously. If this was the case, then $\theta_{11} + \theta_{22} < 1$, which is impossible.) The following is based on the additional assumption that the factor intensities in the construction industry are «between» those in the differentiated goods industries. Then A and hence the determinant are unambiguously positive. Solving (20) and (21) for the change in relative factor prices yields:

$$(22)\ \hat{w}_1 - \hat{w}_2 = \frac{\left(\sigma_2 - \theta_2^H(\sigma_2 - 1)\right)\hat{N}_1 - \left(\sigma_1 - \theta_1^H(\sigma_1 - 1)\right)\hat{N}_2}{\gamma_1\theta_1^H\left(\sigma_2 - \theta_2^H(\sigma_2 - 1)\right) + \gamma_2\theta_2^H\left(\sigma_1 - \theta_1^H(\sigma_1 - 1)\right) + A}$$

Recalling that the absolute value of the pari passu own-price elasticity of demand is equal to $\varepsilon_i^O = \sigma_i - \theta_i^H(\sigma_i - 1)$, (22) may be written:

$$(22')\ \hat{w}_1 - \hat{w}_2 = \frac{\hat{N}_1/\varepsilon_1^O - \hat{N}_2/\varepsilon_2^O}{\gamma_1\theta_1^H/\varepsilon_1^O + \gamma_2\theta_2^H/\varepsilon_2^O + (\theta_{11} - \theta_{21}) + (\theta_{11} - \theta_{K1})(1 - \theta_2^H)/\varepsilon_2^O + (\theta_{22} - \theta_{K2})(1 - \theta_1^H)/\varepsilon_1^O}$$

(22') together with (19) show that $\hat{N}_i$, when divided with the true own-price elasticity of demand, is a relevant indicator of resource allocation effects of the government industrial policy measures considered in this study, when also general equilibrium effects through factor markets are considered. $\hat{N}_i$ represents the shift in the demand curve equivalent to the implemented policy measures. The magnitude of the effect on relative factor prices from changes in the industrial policy variables depends on both demand elasticities, substitution possibilities in production and relative factor intensities. (22') may be regarded as a generalisation of the Stolper-Samuelson theorem for small, open economies in the case with downward sloping demand curves and fixed costs. In the HOS model, shifts in the exogenous price, i.e. shifts in the horizontal demand curves, play the same role as $\hat{N}_i$ (22'). If varieties of the different products are regarded as homogeneous, then $\sigma_1$ and $\sigma_2$ take on infinite values. If there are no fixed costs, $\theta_{K1}$ and $\theta_{K2}$ are zero. If $\sigma_1$ and $\sigma_2$ approach infinity, and $\theta_{K1}$ and $\theta_{K2}$ approach zero, after some rearrangements (22') becomes:

$$(22')\lim_{\sigma\to\infty} \hat{w}_1 - \hat{w}_2 = \frac{\left(\phi_1^H \hat{t}_1 + \left(1-\phi_1^H\right)\hat{e}_1 + \hat{s}_1\right) - \left(\phi_2^H \hat{t}_2 + \left(1-\phi_2^H\right)\hat{e}_2 + \hat{s}_2\right)}{\theta_{11} - \theta_{21}}$$

The term $\phi_i^H \hat{t}_i + \left(1-\phi_i^H\right)\hat{e}_i + \hat{s}_i$ is the equivalent price subsidy when each firm faces a horizontal demand curve. In the basic model, firms have the same market shares on both the home market and the export markets. The relative distribution of sales - in a situation with no government intervention - will be equal to total demand shares. This is why tariffs and export subsidies in (22') are weighted with these demand shares, reflecting the importance of home market demand and export market demand. However, when firms face given prices on all markets, the only way to avoid arbitrage (reexports or reimports) is to have $e_i = t_i$. Then (22') may be written:

$$(22'')\lim_{\sigma\to\infty} \hat{w}_1 - \hat{w}_2 = \frac{\left(\hat{t}_1 + \hat{s}_1\right) - \left(\hat{t}_2 + \hat{s}_2\right)}{\theta_{11} - \theta_{21}}$$

This is exactly the same result as in the original HOS model, and shows that the Stolper-Samuelson result appears as a limiting case of (22'). It shows that commodity taxes are irrelevant for the determination of factor prices and production levels when varieties of a product are regarded as perfect substitutes. Each firm faces horizontal demand curves with prices given from the world market, at least when the economy in question is sufficiently small. This implies that the demand and supply side are «separable», hence commodity taxation that does not discriminate between domestic and foreign varieties, is irrelevant for resource allocation.

To explore the model further, it is useful to consider two additional special cases of (22'). When $\theta_i^H$ and $\phi_i^H$ approach 1, this is equivalent to a closed economy. It is easily seen that in this case (22') reduces to:

$$\hat{w}_1 - \hat{w}_2 = \frac{\left(\hat{s}_1 - \hat{v}_1\right) - \left(\hat{s}_2 - \hat{v}_2\right)}{\gamma_1 + \gamma_2 + \theta_{11} - \theta_{21}}$$

Naturally, tariffs and export subsidies are irrelevant for relative factor prices and hence industry production levels in a closed economy. We also note that subsidies and taxes on capital equipment have no consequences for aggregate industry production. They may of course have consequences for the number of firms and production per firm within an industry, but new entrants will only steal customers from existing *domestic* firms, and since total demand is given, aggregate industry production is unaffected.

When $\theta_i^H$ and $\phi_i^H$ approach 0, we have the case of an «extremely» small and open economy, where the home market represents a negligible fraction of total demand, and domestic production represents an insignificant share of world production. Equation (22) becomes:

$$\hat{w}_1 - \hat{w}_2 = \frac{\sigma_2\left((\sigma_1 - 1)\hat{s}_1 + \sigma_1\hat{e}_1 + \hat{s}_K - \hat{v}_{K1}\right) - \sigma_1\left((\sigma_2 - 1)\hat{s}_2 + \sigma_2\hat{e}_2 + \hat{s}_K - \hat{v}_{K2}\right)}{(\theta_{11} - \theta_{21})(\sigma_1 - 1)(\sigma_2 - 1) + (\theta_{11} - \theta_{K1})(\sigma_1 - 1) + (\theta_{22} - \theta_{K2})(\sigma_2 - 1)}$$

Subsidies and taxes on capital equipment are in this special case important for the determination of relative factor prices and hence for industry production. Whereas the importance of export subsidies is significantly enhanced, tariffs and commodity taxation are no longer important, due to the insignificance of the home market. It is important to note that substitution possibilities in production do not influence the effects on factor prices, as they do in the general case and in the case of a closed economy.

# 4 Empirical illustration: The case of Norway

The main result of the previous section was to show that $\hat{N}_i/\varepsilon_i^o$ is an indicator of the allocation effects of industrial policy, in an economy with a structure as described in section 2. In addition to being a measure of effective assistance, the indicator also reveals what policy measures that are the most important in different industries. Contrasted to a CGE model analysis, an evaluation of industrial policy based on the indicator has much smaller informational requirements. Besides policy parameters, using the indicator requires knowledge of only three sets of parameters: Home market shares of total demand ($\phi_i^H$), domestic producers' share of total supply ($\theta_i^H$) and the elasticity of substitution between varieties of a product ($\sigma_i$). In this section, indicator calculations for 17 Norwegian industries, based on data from 1989, are presented. The policy variables considered are production subsidies, commodity taxation, and import protection. The calculations presented here do not pretend to be more than an illustration.

The calculations of net subsidy rates and commodity tax rates were made as a result of a detailed examination of government budgets and the national accounts. A comprehensive list of the specific subsidies and indirect taxes considered may be found in Hægeland (1994). The estimates of equivalent tariff rates (the protection due to both tariff and non-tariff barriers), are documented in

Fæhn (1996). The main data source for both the estimation of parameters and the calculation of policy variables is the Norwegian National Accounts. The elasticities of substitution ($\sigma_i$) are estimated through calculated markups on marginal costs, cf. equation (7), where buildings and constructions are viewed as fixed costs in all industries. Domestic producers' share of total production, $\theta_i^H$, is set to 0 for industries potentially exposed to international competition and equal to 1 for naturally sheltered industries. This will in general be correct if one assumes that the whole world is the relevant market for all exposed industries. Naturally, the relevance of this assumption may vary between industries. $\phi_i^H$ is set equal to the share of domestic production in an industry delivered to the home market in 1989. Ideally, $\phi_i^H$ should be set equal to (the unobservable) share of home market deliveries in a situation with no active government measures. There is reason to believe that the observed shares may deviate from the «correct» but unobservable shares. However, sensitivity calculations not reported here show that the order of the indicator is not substantially affected by reasonable variations in $\phi_i^H$.

The parameter estimates, the magnitudes of the policy variables and the calculated indicators are all reported in Table 1. Comparing the magnitudes of the policy variables and their respective contributions to the indicator (both with respect to different measures within an industry and a specific measure caress industries), clearly reveals that the relative importance of the policy measures cannot be correctly inferred from studying the magnitudes of the policy variable alone. *Agriculture* stands out as the by far most assisted industry, benefiting greatly from both subsidies and import protection. *Manufacture of Consumption Goods* is also heavily assisted. This is due to protection through non-tariff barriers on processed food and textiles. Also *Fishing and Breeding of Fish* and *Forestry* appear to be considerably assisted compared to the rest of the industries. Note that the naturally sheltered industries are effectively taxed by the policy measures considered here. Another important observation is that for most of the industries net subsidies have the largest impact on the indicator. The calculations show that commodity taxation is of minor importance for allocation effects of industrial policy in Norway. This is mainly due to the fact that the estimated elasticities of substitution are quite large, cf. the discussion in section 3 of what happens when $\sigma \rightarrow \infty$. As discussed in section 2, the indicator does not capture effects via price changes of intermediate inputs due to industrial policy. The results reported in Holmøy and Hægeland (1995) indicate that the first-order effect of changes in prices of intermediate inputs would be largest in *Agriculture* and *Manufacture of Consumption Goods*, but that it would not significantly change the picture from the calculations reported in Table 1.

**Table 1: Indicator calculations for Norway, 1989**

| | PARAMETERS | | POLICY VARIABLES | | | RESULTS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Contributions from | | |
| | $\phi^H$ | $\sigma$ | Net subsidy rate (s) | Equivalent tariff rate (t) | Commodity tax rate (v) | TOTAL $\hat{N}/\varepsilon^{\circ}$ | Subsidies | Tariffs and NTBs | Commodity taxes. |
| *Potentially exposed industries* ( $\theta^H = 0$ ) | | | | | | | | | |
| Agriculture | 0.98 | 3.5 | 43.3 | 70.6 | 0.5 | **80.2** | 30.9 | 49.4 | -0.1 |
| Forestry | 0.94 | 4.4 | 9 | 0.2 | 0 | **7.1** | 7.0 | 0.1 | 0.0 |
| Fishing and Breeding of Fish | 0.74 | 16.3 | 10.4 | 0 | 0.1 | **9.8** | 9.8 | 0.0 | 0.0 |
| Manufacture of Consumption Goods | 0.85 | 25.9 | 0.4 | 36.4 | 11.6 | **29.7** | 0.4 | 29.7 | -0.4 |
| Manufacture of Intermediate Inputs and Capital Goods | 0.8 | 20.8 | 1.3 | 3.5 | 0.6 | **3.9** | 1.2 | 2.7 | 0.0 |
| Manufacture of Pulp and Paper Articles | 0.52 | 34 | 0.3 | 0 | 0.5 | **0.3** | 0.3 | 0.0 | 0.0 |
| Manufacture of Industrial Chemicals | 0.41 | 32.1 | 0.2 | 3.3 | 0.9 | **1.5** | 0.2 | 1.3 | 0.0 |
| Petroleum Refining | 0.44 | 24.3 | 0 | 0 | 78.8 | **-1.4** | 0.0 | 0.0 | -1.4 |
| Manufacture of Metals | 0.17 | 18.4 | 0.4 | 0.2 | 0 | **0.4** | 0.4 | 0.0 | 0.0 |
| Manufacture of Metal Products, Machinery and Equipment | 0.59 | 26.8 | 0.6 | 3.8 | 0.7 | **2.7** | 0.6 | 2.2 | 0.0 |
| Building of Ships and Oil-Platforms | 0.92 | 33.8 | 2.4 | 2.1 | 0.1 | **4.2** | 2.3 | 1.9 | 0.0 |
| *Naturally sheltered industries* ( $\theta^H = 1$ ) | | | | | | | | | |
| Construction excl. Oil Well Drilling | 1 | 152.6 | -0.2 | 0 | 0 | **-0.2** | -0.2 | 0.0 | 0.0 |
| Finance And Insurance | 0.99 | 25.1 | -0.4 | 0 | 0 | **-0.4** | -0.4 | 0.0 | 0.0 |
| Domestic Transport | 0.91 | 10.1 | -0.2 | 0 | 0 | **-0.2** | -0.2 | 0.0 | 0.0 |
| Wholesale And Retail Trade | 0.87 | $\infty$ | -4.6 | 0 | 1.4 | **-5.8** | -4.6 | 0.0 | -1.2 |
| Dwelling Services | 1 | 1.2 | -1.6 | 0 | 0 | **-1.6** | -1.6 | 0.0 | 0.0 |
| Other Private Services | 0.98 | 9.1 | -0.3 | 0 | 0 | **-0.3** | -0.3 | 0.0 | 0.0 |

# 5 Concluding remarks

In this paper, a theory-consistent indicator of the allocation effects of industrial policy under monopolistic competition, translating policy shifts into equivalent demand curve shifts, has been proposed. The indicator is a summary measure of industrial policy. It also shows the relative importance of different policy measures. The major advantage of the «indicator approach» is that once a relevant indicator is constructed, it is relatively easy to draw a qualitative picture of how industrial policy affects resource allocation. As opposed to a CGE model, using the indicator requires knowledge of only a small set of parameters. Although less sophisticated, the transparency and small informational requirements of the indicator suggest that it may serve as an efficient alternative to numerical general equilibrium models, especially in matters of international comparisons of industrial policy.

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