A convenient multi sectoral policy control for ICT in the USA economy

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Abstract

Through the application of the Macro Multiplier approach on a multi-sectoral model for the USA, the paper identifies the "convenient" structure of a policy control on final demand, oriented to a particular policy objective (industry output), focusing on the Information and Communication Technology sector (ICT sector). The method used is based on a specific matrix decomposition that allows for the quantification of an aggregated scale-effect, called Macro Multiplier, that affects the objective (endogenous) variable each time the policy (exogenous) control assumes a specific structure. This type of quantification is of aggregated type, since the scalars obtained are valid for all sectoral components of both the policy variable and the objective variable. But it does not violate the conditions put forward by the aggregation theory, since the aggregated Macro Multipliers are consistent with the multi-sectoral features of the model. Once identified the structures and the associated Macro Multipliers, the policy maker can have a complete picture of the patterns of the objective variable that can be attained and determine a "convenient" structure of the policy variable that compels the model towards those patterns. This is done choosing either one structure or a combination of the structures identified for the policy control. The application is done on data of the United State (U.S.) Input-Output table (Industry by Industry) for the year 2005. ICT manufacturing and service sectors are built following the indications of the OECD.

Keywords: ICT, Structural Change, Multipliers Analysis, IO model.
JEL classification: C67, D31, D57, R15

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1 Information and Communication Technology industry

Information and Communication Technology (ICT) is a crucial industry in the economy system of all developed countries. Its pivotal function within the post industrial economy make it one of the drives of the economic and the productivity growth (Jorgenson, 2001)[1]. The attention of the major portion of the theoretical analysis is usually focused on the contribution of the ICT to overall production system and often the factors improving the ICT industry are neglected (Bernstein, 2000). In order to reverse this typical approach we need to perform a detailed analysis on the final demand policies which may generate ICT industry development.

In this context, a particular attention must be focused on the production process of ICT goods. Normally, whereas the ICT sector still accounts for a relatively small share of total industries, about 10% in 2000 as an average of all Oecd countries (OECD, 2002), ICT output can give a relatively large contribution to GDP growth. Thus because of its very rapid diffusion as intermediate good within the productive systems and besides owing to the amount of resources devoted to new information technologies in terms of investment or innovative effort made by the economic system as a whole. In this respect and only very recently the Oecd member countries agreed on a definition of the ICT sector in order to evaluate both the size and the contribution of this activity on the GDP growth. The definition, based on the international standard classification of activities (ISIC Rev.3), characterizes the ICT industry as a combination of manufacturing and services sectors.

The existence of a widely accepted definition of the ICT industry enhance to compare it across countries. First comparing ICT manufacturing industry to total manufacturing activities, the countries as Korea, Finland, Sweden, reveal a specialization in ICT industries over the 20%, well above the shares for Japan and United States (11% in 1999). In a broader context the composition of ICT production differs across Oecd members. The importance of the ICT sector within Oecd economies has been growing over the 1990s and a rapid growth is apparent in northern European countries as Finland, Sweden, Norway, the Netherlands and the United Kingdom where ICT sector's share of value added increased by 7.2 percentage points over the 1995-2000 period and now represents over the 15%. Most of the Oecd countries already have a developed telecommunication services sector which is

[1]A detailed definition of ICT industry will be later explained.

reflected in its sizeable contribution to ICT sector value added. Some of Oecd countries such as Ireland, Japan and Mexico are specialised in the manufacture of ICT goods of which the largest contribution typically comes from the manufacture of telecommunication equipment. Finally, ICT services such as telecommunication and computer services generally constitute between 70% and 90% of total ICT sector value added.

Through the linkages analysis we can evaluate the importance of ICT industry on the U.S. economy (Mun and Nadiri, 2002). This analysis is performed on an Input-Output table, [65,65], for the 2005 that has an Industry by Industry structure through which appraise the Industry weight including in the ICT definition (Backward or power of dispersion and forward or sensitivity of dispersion) (Rasmussen, 1956).

In this perspective, ICT industry includes: 21 (Computer and electronic products), 22 (Electrical equipment, appliances, and components), 27 (Wholesale trade)[2], 37 (Publishing industries -includes software-), 38 (Motion picture and sound recording industries), 39 (Broadcasting and telecommunications), 40 (Information and data processing services) and 49 (Computer systems design and related services).

Focusing on the result of the linkages index for ICT industry on figure 1 and observing the skill of industry to activate the productive process of their suppliers we can emphasize the importance of industries 21 (Computer and electronic products), 22 (Electrical equipment, appliances, and components), 39 (Broadcasting and telecommunications) and 38 (Motion picture and sound recording industries).

Moreover, observing the contribution of each ICT industry on a growth of final demand as a whole we observe that some of them are relevant: (figure 2) 27 (Wholesale trade), 39 (Broadcasting and telecommunications) and 21 (Computer and electronic products).

In our work we attempt to find which is the best composition of exogenous variable to obtain a particular effect on objective variable. The propagation analysis we propose is based on a decomposition that allows for the identification and quantitative determination of aggregated Macro Multipliers (MM), which lead the economic interactions, and the structures of macroeconomic variables, that either hide or activate these forces. They are aggregated multipliers consistently extracted from a multisectoral framework and their meaning holds both if we speak in aggregated or disaggregated terms. The analysis will be

[2]The Wholesale industry is not a ICT industry as a whole but the lack of date compel to include it completely within the ICT definition.

applied to the final demand-total output loop. We will consider the effect of a demand change (control) considered as policy variable on total output. However the same analysis could be generalized to a wider loop where value added and income distribution can also consider. It will identify the most convenient structure for the aims of the policy maker (Ciaschini and Socci, 2006).

Section 2 shows the methodology of the Macro Multipliers based on the singular values decomposition related to eigenvalues decomposition and define MM approach. Section 3 the deterministic analysis of propagation is performed in order to identify and quantify all the MM that rule the economic interactions. This section determine a "convenient" structure of the policy variable for ICT industry choosing either one structure or a combination of the structures identified.

2 Methodology: Macro Multipliers approach

The original Input-Output (I-O) problem is to search the output vector consistent with final demand vector for I-O sectors, given structural interrelation among industry sector. Such a vector conveniently faces the predetermined final demand vector $\mathbf{f}$ by industries, and the induced industrial demand.

The equilibrium output vector is given by

$$\mathbf{x} = \mathbf{R} \cdot \mathbf{f} \tag{1}$$

where $\mathbf{R} = [\mathbf{I} - \mathbf{A}]^{-1}$ and $\mathbf{A}$ is the constant technical coefficients matrix, and generally exists, as in general the technology can be expected to be productive, i.e. the technology is such that a part of total output is still available for final uses, after the intermediate requirements have been satisfied. In this case, $\mathbf{A}$ satisfies the Hawkins-Simon conditions. The $\mathbf{R}$ matrix is usually referred to as the Leontief multipliers matrix (Leontief, 1965) and its elements, r_{ij}, show the direct and indirect requirements of industry output i per unit of final demand of product at industry j. Extensive use is made of matrix $\mathbf{R}$ within the traditional multipliers analysis. The $\mathbf{R}$ matrix provides, in fact, a set of disaggregated multipliers that are recognized to be the most precise and sensitive for studies of detailed economic impacts. These multipliers recognize the evidence that total impact on output will vary depending on which industries are affected by changes in final demand. The i^{th} total output multiplier measures the sum of direct and indirect input requirements needed to satisfy a unit final demand for goods produced by industry i.

It has to be stressed, however, that all these measures, built starting from matrix $\mathbf{R}$, are not independent of structure of the either total output vector, neither which we observe the effects, nor of structure of final demand vector on which we impose the unit demand shock.
The column and row sum of the $\mathbf{R}$ matrix in equation 1 implies the consideration of a set of final demand vectors where its structures are predetermined.

We can expect that these measures hold for demand vectors of varying scale but with the same structures. However neither the demand vector nor its changes will ever assume a structure of this type. This is why some authors come to the drastic conclusion that "multipliers should be never used" (Skolka, 1986).

On the other hand it is a common opinion that the structure of final demand produces the most different effects on the level of total output (Ciaschini, 1989). Given a set of nonzero final demand vectors, whose elements sum up to a predetermined level, but with varying structures, we will have to expect that the corresponding level of total output will also vary considerably.

For these reasons we cannot confine our knowledge of the system to the picture emerging from measures which can only show what would happen if final demand assumed a predetermined and unlikely structure.

The structural matrix $\mathbf{R}$ of our model can be easily decomposed in a sum of m different matrices through the Singular Values Decomposition (Ciaschini, 1993).

The decomposition proposed can be applied both to square and to non-square matrices. Here the general case of square matrix $\mathbf{R}$ will be shown[3]. For example given 2x2 model we will show a Singular Values Decomposition. Let us consider matrix $\mathbf{W}$ $[2, 2]$, for example, the square of matrix $\mathbf{R}$:

$$\mathbf{W} = \mathbf{R}^T \cdot \mathbf{R}$$

Matrix $\mathbf{W}$ has a positive definite or semi definite square root. Given that $\mathbf{W} \geq 0$ by construction, its eigenvalues λ_i for $i = 1, 2$ shall be all real non negative (Lancaster and Tiesmenetsky, 1985).

The nonzero eigenvalues of matrices $\mathbf{W}$ and $\mathbf{W}^T$ coincide. The system of eigenvectors $[\mathbf{u}_i \; i = 1, 2]$ for $\mathbf{W}$ and $[\mathbf{v}_i \; i = 1, 2]$ for $\mathbf{W}^T$ are orthonormal basis.
We get then

$$\mathbf{R}^T \cdot \mathbf{u}_i = \sqrt{\lambda_i} \cdot \mathbf{v}_i \qquad i = 1, 2$$

[3]The non-square matrix case is easily developed along the same lines.

We can construct the two matrices

$$\mathbf{U} = [\mathbf{u}_1, \mathbf{u}_2] \qquad \mathbf{V} = [\mathbf{v}_1, \mathbf{v}_2]$$

As defined above, the eigenvalues of $\mathbf{W}$ coincide with singular values of $\mathbf{R}$ hence $s_i = \sqrt{\lambda_i}$ and we get

$$\mathbf{R}^T \cdot \mathbf{U} = [s_1 \cdot \mathbf{v}_1, s_2 \cdot \mathbf{v}_2] = \mathbf{V} \cdot \mathbf{S}$$

Structural matrix $\mathbf{R}$ in equation 1 can be then decomposed as

$$\mathbf{x} = \mathbf{U} \cdot \mathbf{S} \cdot \mathbf{V}^T \cdot \mathbf{f} \tag{2}$$

$\mathbf{V}$ is an $[2,2]$ unitary matrix whose columns define the 2 reference structures for final demand:

$$\mathbf{v}_1 = \begin{bmatrix} v_{1,1} & v_{1,2} \end{bmatrix}$$

$$\mathbf{v}_2 = \begin{bmatrix} v_{2,1} & v_{2,2} \end{bmatrix}$$

$\mathbf{U}$ is an $[2,2]$ unitary matrix whose columns define 2 reference structures for output:

$$\mathbf{u}_1 = \begin{bmatrix} u_{1,1} \\ u_{2,1} \end{bmatrix}, \mathbf{u}_2 = \begin{bmatrix} u_{1,2} \\ u_{2,2} \end{bmatrix}$$

and $\mathbf{S}$ is an $[2,2]$ diagonal matrix of the type:

$$\mathbf{S} = \begin{bmatrix} s_1 & 0 \\ 0 & s_2 \end{bmatrix}$$

Scalars s_i are all real and positive and can be ordered as $s_1 > s_2$. Now we have all the elements to show how this decomposition correctly represents the MM that quantify the aggregate scale effects and the associated structures of the impact of a shock in final demand on total output. In fact if we express the actual vector $\mathbf{f}$ in terms of the structures identified by matrix $\mathbf{V}$, we obtain a new final demand vector, $\mathbf{f}^0$, expressed in terms of the structures suggested by the $\mathbf{R}$:

$$\mathbf{f}^0 = \mathbf{V} \cdot \mathbf{f} \tag{3}$$

On the other hand we can also express total output according the output structures implied by matrix $\mathbf{R}$:

$$\mathbf{x}^0 = \mathbf{U}^T \cdot \mathbf{x} \tag{4}$$

Equation 2 then becomes through equations 3 and 4:

$$\mathbf{x}^0 = \mathbf{S} \cdot \mathbf{f}^0 \tag{5}$$

which implies:

$$x_i^0 = s_i \cdot f_i^0 \tag{6}$$

where $i = 1, 2$. We note that matrix $\mathbf{R}$ hides 2 fundamental combination of the outputs. Each of them is obtain multiplying the corresponding combination of final demand by a predetermined scalar which has in fact the role of aggregated Macro Multiplier.

The complex effect on the output vector of final demand shocks can be reduced to a multiplication by a constant s_i.

The structures we have identified play a fundamental role in determining the potential behavior of the economic system, i.e. the behavior of the system under all possible shocks. We can in fact evaluate which will be the effect on output of all final demand possible structures.

When final demand vector crosses a structure in $\mathbf{V}$, the vector of total output crosses the corresponding structure in $\mathbf{U}$ and the ratio between the moduli of the two vectors is given by the corresponding scalar s. Singular values s_i, then, determine the aggregated effect of a final demand shock on output. For this reason we will call them Macro Multipliers (Ciaschini and Socci, 2007). These MM are aggregated, in the sense that each of them applies on all components of each macroeconomic variables taken into consideration, and are consistent with the multi-industry specification of the model[4].

As we see from figure 4 it exist a "dominating" policy structure $\mathbf{v}_1$ which, when activated, produces the largest effect $s_1 \cdot \mathbf{u}_1$. For policy purposes, however, we could be interested in a sub-dominating policy which does not produce greatest effect but favors same pre-determined sectors. In this case the policy structure will be given by a combination of the two policies according a convenient coefficients a_1 and a_2 where $a_2 = 1 - a_1$ $(0 < a_1 < 1)$.

$$\mathbf{f}^* = \mathbf{v}_1 \cdot a_1 + \mathbf{v}_2 \cdot a_2 \tag{7}$$

Its effect on total output will be by same combination

$$\mathbf{x}^* = [s_1 \cdot \mathbf{u}_1] \cdot a_1 + [s_2 \cdot \mathbf{u}_2] \cdot a_2 \tag{8}$$

[4]Given the problems connected with aggregation in multisectoral models, this feature of singular values s_i is not of minor relevance. They are aggregated multipliers consistently extracted from a multisectoral framework and their meaning holds both if we speak in aggregated or disaggregated terms.

In our original $[m,m]$ model, we can than say that, given our matrix $\mathbf{R}$, we are able to isolate impacts of different (aggregate) magnitude, since that MM present in matrix $\mathbf{R}$, s_i can be activated through a shock along the demand structure $\mathbf{v}_i$ and its impact can be observed along the output structure $\mathbf{u}_i$.

3 Empirical analysis: a convenient final demand structure for ICT industry

Policy objectives of demand control can be designed with reference either to the whole producing system or to specific outputs. However even when considering specific outputs we need to consider the entire producing structure given the interactions among branches. Our aim is to identify the demand control policies (instrument variable) that promote for example the wine sectors (4 and 5) within the realized total output (objective variable). The fundamental intersectoral relationship between the policy control on final demand $\Delta\mathbf{f}$ and the resulting change in the objective variable, total output, $\Delta\mathbf{x}$, is given by:

$$\Delta\mathbf{x} = [\mathbf{I} - \mathbf{A}]^{-1} \cdot \Delta\mathbf{f} \tag{9}$$

The problem will be that of quantifying, given the aggregate value of the policy control $\| \Delta\mathbf{f} \|$ that we need to activate, the resulting aggregate value of total output $\| \Delta\mathbf{x} \|$; and of identifying which structures will be most suitable in order to activate structures most favorable to wine sectors within the objective variable.

In this application matrix $\mathbf{A}$ is the technical coefficient matrix for USA (Lawson *et al.*, 2005) in the year 2005 with 65 Industries disaggregation[5].

The aim is to identify a particular structure of final demand which has a positive effect on the growth of ICT industry as a whole without neglecting the effects on the other industry within the productive system. Here the Macro Multiplier approach allows to identify the convenient final demand shock and compare the results in spite of the results reached with the traditional Leontief multipliers.

The policy variable (demand) has 65 demand sectors as well as the objective variable (total output). Applying Singular Values Decomposition we obtain a set of 65 Macro Multipliers, a set of 65 (linearly independent) structures of demand control each one activating the cor-

[5]See table 2 for the Industry classification (NAICS). For the I-O table see www.bea.gov/bea

responding multiplier and a set of 65 (linearly independent) structures each one under the impact of the corresponding multiplier.

Matrix $[\mathbf{I}-\mathbf{A}]^{-1}$, then, hides a set of multipliers that can be stimulated by convenient structures (compositions) of the policy control and observed on the corresponding structures of the objective variable. The set of Macro Multipliers are shown in figure 5 where they have been arranged in decreasing order of magnitude.

In particulare, observing each structures $s_i \cdot \mathbf{u}_i$ it is possible to pick out one or more final demand composition oriented to ICT industry (see table 3). The matrix has the following structures of final demand:

- $\mathbf{v}_{12}$ for the Computer and electronic products
- $\mathbf{v}_{29}$ for the Electrical equipment, appliances, and components
- $\mathbf{v}_1$ for the Wholesale trade
- $\mathbf{v}_{30}$ for the Publishing industries -includes software-
- $\mathbf{v}_{10}$ for the Motion picture and sound recording industries
- $\mathbf{v}_{12}$ for the Broadcasting and telecommunications
- $\mathbf{v}_{50}$ for the Information and data processing services
- $\mathbf{v}_{40}$ for the Computer systems design and related services

The more suitable structure for ICT industry as a whole is the structure policy control (final demand) $\mathbf{v}_1$.

Let us concentrate on what we will define as "policy 1", which is in fact the "dominating policy". Policy 1 will be characterized by structure 1, $\mathbf{v}_1$, of the policy control as shown in figure 7, whose aggregated value will be determined by its modulus $||\mathbf{v}_1||$, in our experiment $||\mathbf{v}_1|| = 1$. Its aggregated effect on the objective variable (total output) will be determined by $s_1 \cdot ||\mathbf{u}_1|| = 2.29$. Such effect will be observed on objective structure 1, $\mathbf{u}_1$ and will be equal to $s_1 \cdot \mathbf{u}_1$ as in figure 6.

Policy 1 has two relevant features. Firstly it is a demand policy that has the highest multiplier effect on output: a generic change in final demand vector will be characterised by the effect of this multiplier. Only when the demand change has precisely structure 1 we get the highest effect on output. Secondly it exists an expansion of all sectors of final demand that results in an expansion of all sectors of total output, consistently with what one should expect from a priori theory.

In particular the objective structure 1, which is the effect of policy 1 on output, tends to expand the ICT industries. As we can observe in table 1 the policy 1 generates a change of 1487 on total output do to an expansion of final demand of 738.

Table 1: Policy 1 (dominating policy)

	ICT industries	output $s_1 \cdot \mathbf{u}_1$	input $\mathbf{v}_1$
21	Computer and electronic products	32	15
22	Electrical equipment, appliances, and components	18	12
27	Wholesale trade	60	15
37	Publishing industries (includes software)	14	8
38	Motion picture and sound recording industries	13	8
39	Broadcasting and telecommunications	39	15
40	Information and data processing services	14	9
49	Computer systems design and related services	11	5
	total ICT effect	201	87
	total output effect	1487	738

The ICT output variation is equal to 201 while the variation of the component of the ICT final demand is 87. Within the ICT industry 27 Wholesale trade, 39 Broadcasting and telecommunications and 21 Computer and electronic products get the higher effects.

If we have not the exclusive objective of activating the "dominating policy" and are interested in warranting a positive impact on specific industry of the ICT, as for example the "Computer and electronic products" industry, we have to examine carefully the effects on these industry outputs of all the 65 policies. As shown in table 3 the structures of the objective variable (total output) of specific interest for the "Computer and electronic products" industry which can be activated are structure nr. 12.

Policy control 12, as shown in figure 8, seems more suited when a policy in favor of "Computer and electronic products is designed. In these structure "Computer and electronic products" industry is stimulated at an higher degree with respect to the remaining structures.

In figure 8 we show the effect on total output of "Computer and electronic products" policy control when we use policy control 12. In particular, in structure 12 "Computer and electronic products" industry get a major share of the total effect[6].

Moreover positive impacts are to be detected on the ICT output of industry 38 (Motion picture and sound recording industries), 27

[6]See figure 9 for structure of control final demand 12 and figure 8 for its multi-sectoral effect.

(Wholesale trade), 37 (Publishing industries), 49 (Computer systems design and related services) and 22 (Electrical equipment, appliances, and components). Negative impact on ICT is shown from 39 (Broadcasting and telecommunications).

As we see from table 4 if we decide to adopt this structure the effect is a trade-off within the positive effect on this sub-sector of ICT industry and the total effect on the economic system as a whole.

In this respect, the aim is to construct a linear combination of both the two policy structures in order to mitigate the negative effect on total output and confirming the positive effect on 21 industry. With respect to equations 7 and 8 we want to identify a final demand structure which balances the effects do to both the dominant policy (v_1) and the policy (21) which we identified as favorable for the "Computer and electronic products" .

In aggregated terms the effects of the combination of the two policies can be evaluated considering the ratio between the modulus of the policy control (demand change) and the modulus of the corresponding change in the objective variable (total output change), as shown in figure 10.

In table 5 we can observe the main results of the combination between the policy structure 12 and the 1. As shown by the two last columns, if we only use the 12 (($a_1 = 0$)) in order to construct the final demand shock, the output by industry 21 increase from 32 to 73 instead of a reduction of the total output for the whole economy (-7).

The negative effect on total output may be mitigate when the combination of two structures are taken with coefficients $a_2 = 0.8$. As shown in figure 8 the negative variation of output by industry 39 Broadcasting and telecommunications is less emphasized instead of a combination of structures 12 and 1 constructed with coefficient $a_2 = 0.2$ where the effect became positive one. Using the structure $0.2v_{12}+0.8v_1$ we also can observe a growth on output of the ICT industry as a whole.

We will choose combination 0.2 of policy 12 and 0.8 of policy 1 since we see from the previous picture that their combined aggregated effect amounts to 1188, mentre l'output dell'ICT passa a 180. The representation of these structures as a whole is shown in figure 11.

The effects on the structure of total output of this combined policy follow mainly (80%) the effects of policy 1. However the impact of policy 12 can be detected, for example, for the two wholesale trade sectors and agriculture. The demand control that realizes the output structure shown in the previous figure will be then given by a combination of the two policies according the weights 0.2 and 0.8 as show in figure 12.

4 Conclusions

The analysis proposed in this paper focuses on the role played by the sectoral composition of macroeconomic variable. Each macroeconomic variable is decomposed into an aggregated scale component and a disaggregated structure component through a rigorously consistent procedure. This allows for the determination of all specific structures that rule the loop between the policy control and the policy objective.

The policy problem is then transformed into the choice of a "convenient" structure for the policy control. This structure is taken out from a set of structures which are predetermined by the data of the problem, or is given by a combination of two or more of them.

The suitability of the chosen policy structure will be evaluated both according the aggregated scale effect and according the structure of the policy objective. According the scale effect when we choose a policy structure different from the "dominating" one we get a loss in the overall policy effectiveness which is quantified by the difference between the "dominating" multiplier and that associated with the policy chosen. The overall effectiveness loss has to be then justified vis-à-vis with the attainment of a new structure of the objective variable. Such new structure should appear more suitable than the dominating one if it generates balancing adjustments in the composition of the objective.

The application shows the two cases. Firstly, policy 1 has been determined. This is a "pure" policy in the sense that is not a combination of two or more pure policies (linearly independent). It is also the "dominating" policy since it makes the highest multiplier emerge through the sectors of the objective variable. Secondly, a specific ICT-promoting policy is determined as combination of two "pure" policies whose impact on "Computer and electronic products" is as large as possible while the overall multiplier is lower then the dominating 1.

More complex combinations of policies can be designed starting from a careful scrutiny of the set of "pure" policies that completely determine the behavior of our Leontief inverse.

They would possibly give a deeper and more creative insight of the inter-industry interaction then that provided by the assumption of equi-distributed (or impulsive) demand-shocks which are pervasive in the traditional analysis.

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Table 2: Input-Output industries classification

1	Farms	**34**	Pipeline transportation
2	Forestry, fishing, and related activities	**35**	Other transportation and support activities
3	Oil and gas extraction	**36**	Warehousing and storage
4	Mining, except oil and gas	**37**	Publishing industries (includes software)
5	Support activities for mining	**38**	Motion picture and sound recording industries
6	Utilities	**39**	Broadcasting and telecommunications
7	Construction	**40**	Information and data processing services
8	Food and beverage and tobacco products	**41**	Federal Reserve banks, credit intermediation, and related activities
9	Textile mills and textile product mills	**42**	Securities, commodity contracts, and investments
10	Apparel and leather and allied products	**43**	Insurance carriers and related activities
11	Wood products	**44**	Funds, trusts, and other financial vehicles
12	Paper products	**45**	Real estate
13	Printing and related support activities	**46**	Rental and leasing services and lessors of intangible assets
14	Petroleum and coal products	**47**	Legal services
15	Chemical products	**48**	Miscellaneous professional, scientific and technical services
16	Plastics and rubber products	**49**	Computer systems design and related services
17	Nonmetallic mineral products	**50**	Management of companies and enterprises
18	Primary metals	**51**	Administrative and support services
19	Fabricated metal products	**52**	Waste management and remediation services
20	Machinery	**53**	Educational services
21	Computer and electronic products	**54**	Ambulatory health care services
22	Electrical equipment, appliances, and components	**55**	Hospitals and nursing and residential care facilities
23	Motor vehicles, bodies and trailers, and parts	**56**	Social assistance
24	Other transportation equipment	**57**	Performing arts, spectator sports, museums, and related activities
25	Furniture and related products	**58**	Amusements, gambling, and recreation industries
26	Miscellaneous manufacturing	**59**	Accommodation
27	Wholesale trade	**60**	Food services and drinking places
28	Retail trade	**61**	Other services, except government
29	Air transportation	**62**	Federal government enterprises
30	Rail transportation	**63**	Federal general government
31	Water transportation	**64**	State and local government enterprises
32	Truck transportation	**65**	State and local general government
33	Transit and ground passenger transportation		

Figure 1: Backward linkages for ICT in USA (2005)

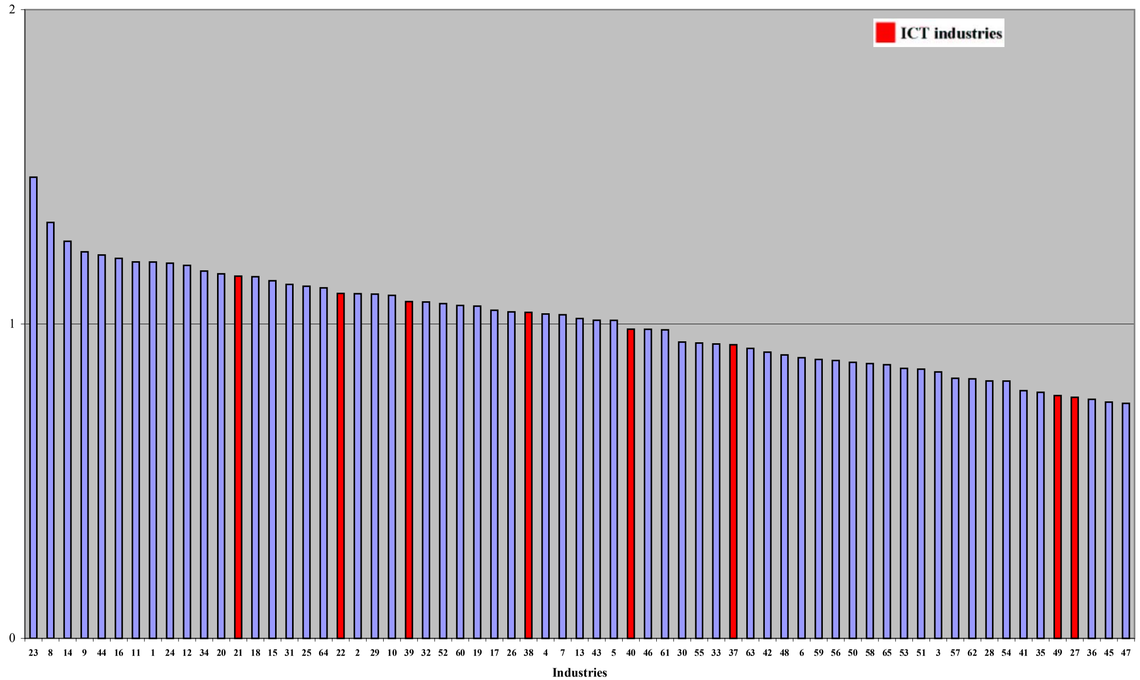

Figure 2: Forward linkages for ICT in USA (2005)

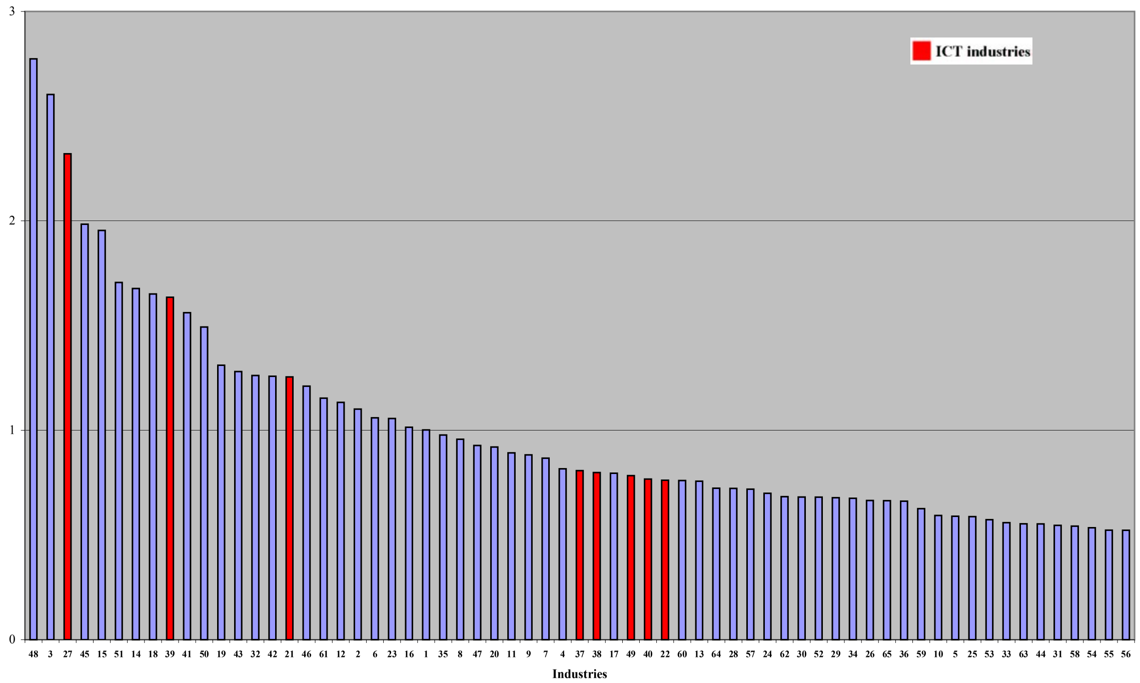

Figure 3: Leontief Multipliers in Macro Multipliers

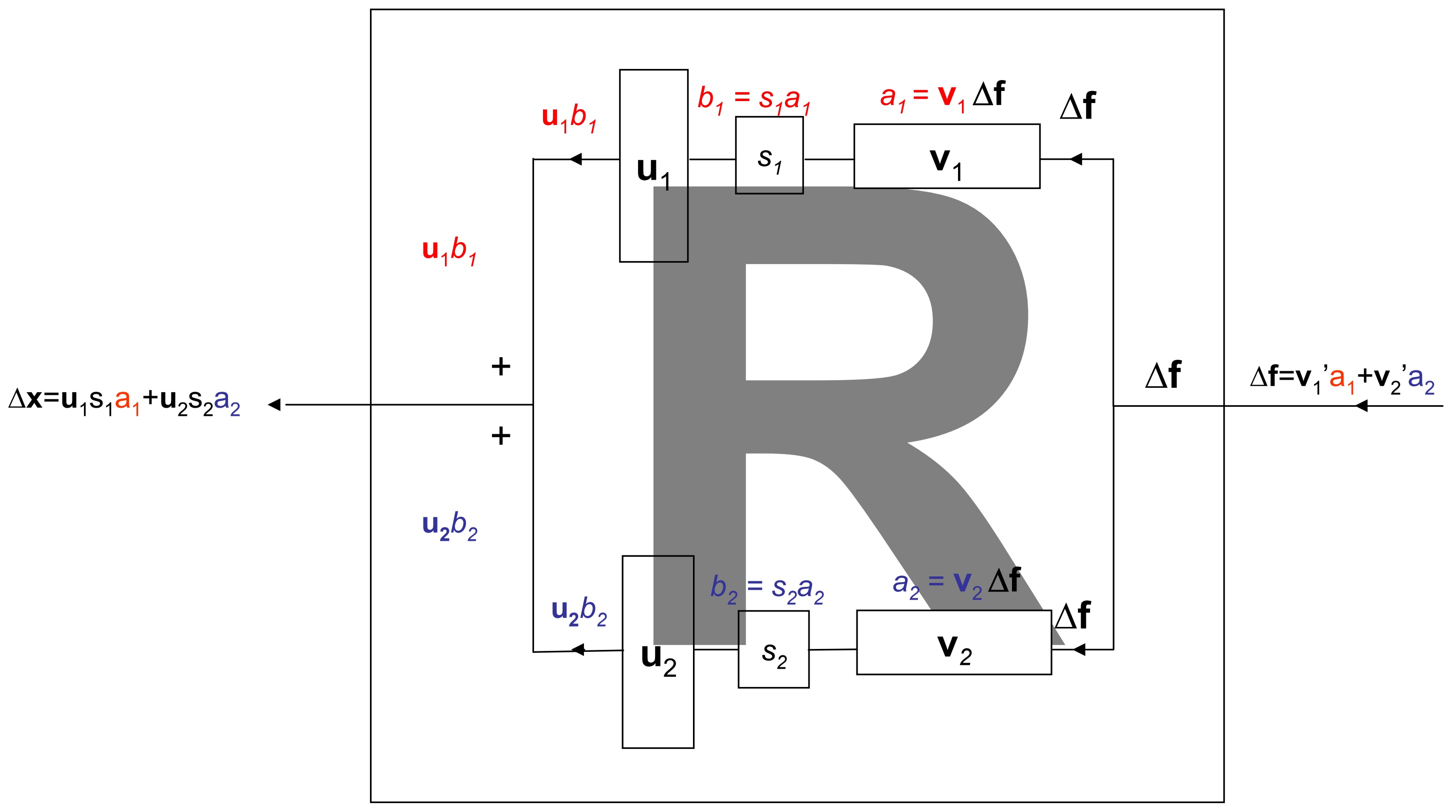

Figure 4: Dominating policy in Macro Multipliers

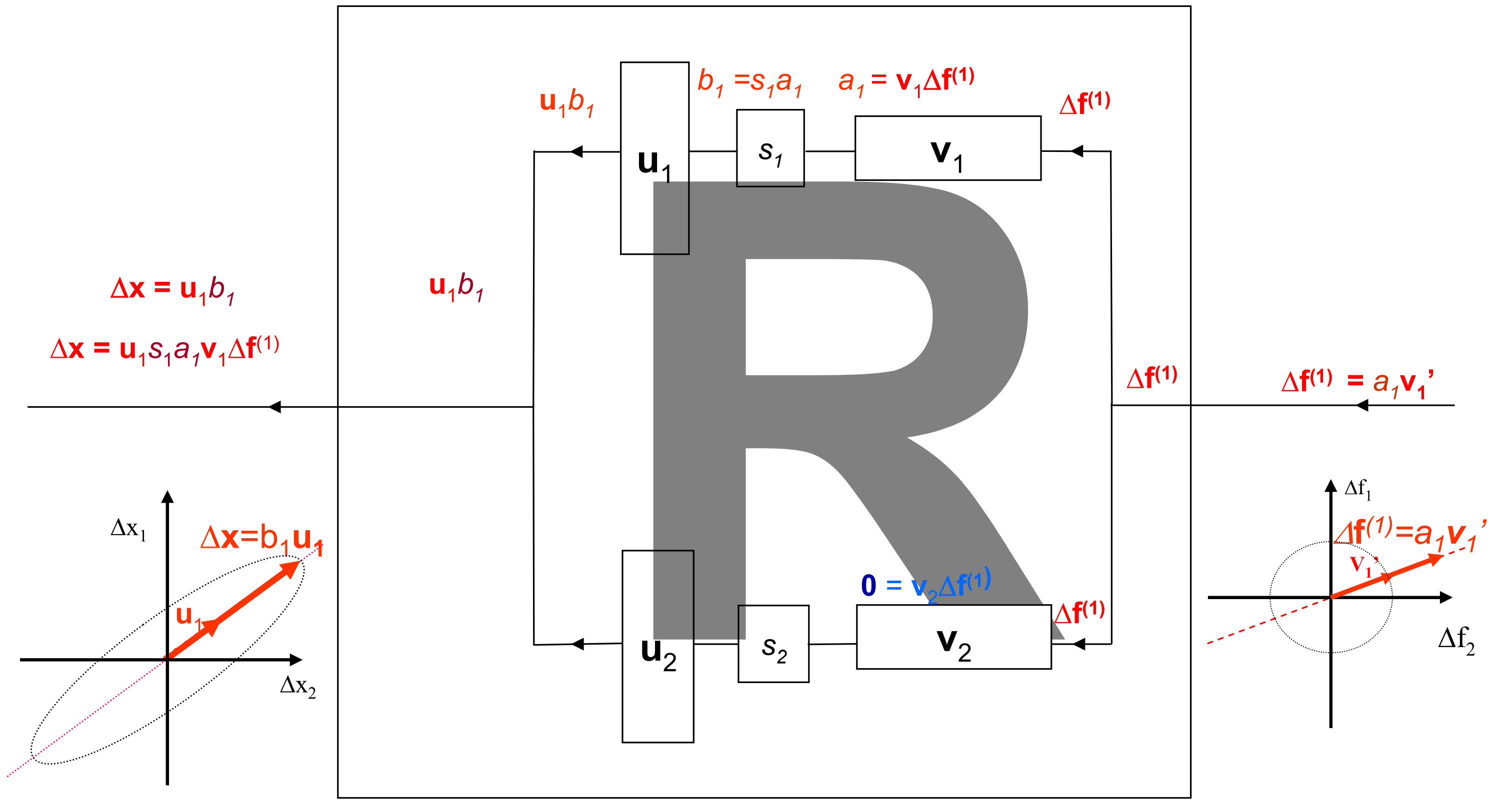

Figure 5: Macro Multipliers

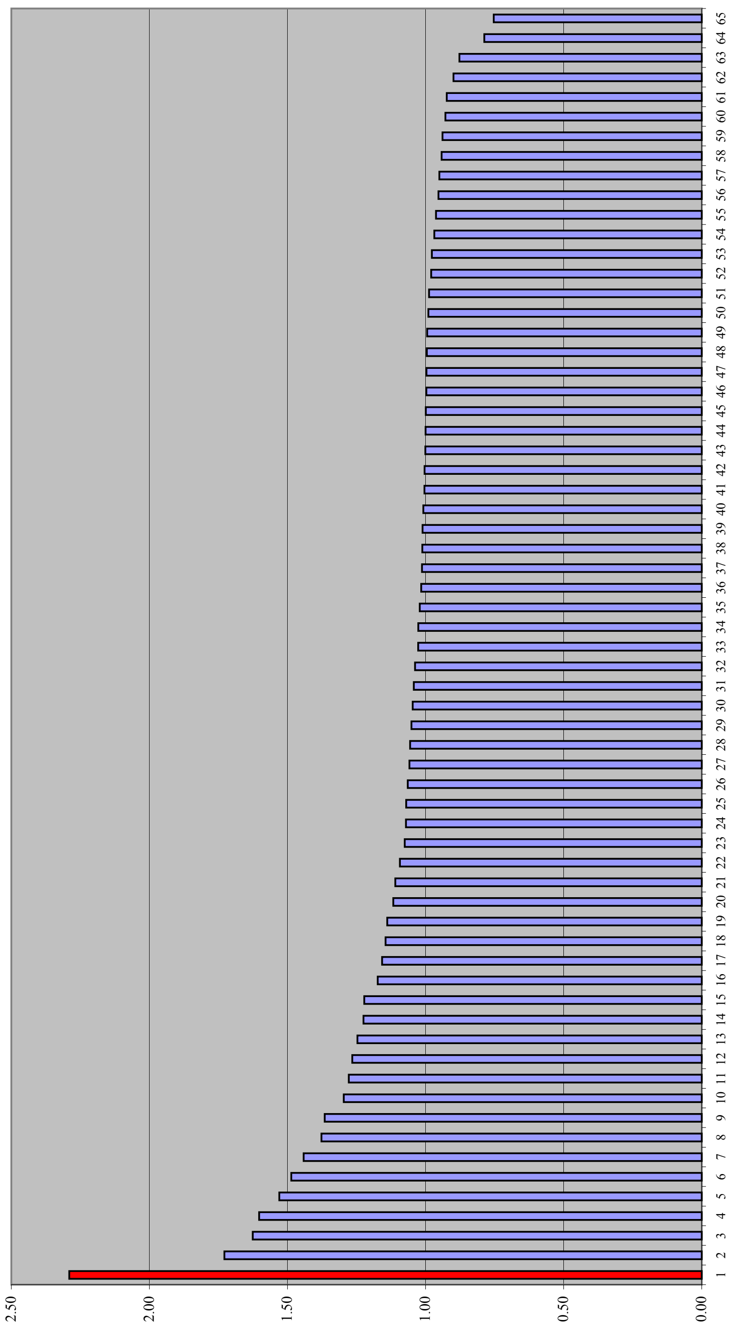

Table 3: Effect on total output of policy 1, 10, 12, 29, 30, 40 e 50

Industries	$s_1\mathbf{u}_1$	$s_{10}\mathbf{u}_{10}$	$s_{12}\mathbf{u}_{12}$	$s_{29}\mathbf{u}_{29}$	$s_{30}\mathbf{u}_{30}$	$s_{40}\mathbf{u}_{40}$	$s_{50}\mathbf{u}_{50}$
1	0.275	-0.099	-0.049	0.123	-0.069	0.001	0.042
2	0.256	-0.144	-0.035	-0.016	0.011	0.014	0.002
3	0.934	-0.062	-0.073	-0.007	-0.027	-0.027	0.031
4	0.183	-0.006	0.074	-0.273	0.057	0.053	-0.048
5	0.123	-0.002	0.030	0.312	0.067	-0.025	0.126
6	0.255	0.005	-0.010	-0.098	0.010	-0.173	0.209
7	0.169	0.040	0.074	-0.089	0.110	0.023	0.009
8	0.253	0.026	-0.053	-0.071	0.083	0.026	-0.046
9	0.240	-0.306	0.139	0.024	0.048	-0.042	-0.007
10	0.109	-0.095	0.070	-0.072	-0.032	0.108	0.005
11	0.200	0.159	0.153	0.035	0.001	-0.070	-0.024
12	0.291	0.771	-0.254	-0.001	0.175	0.041	0.030
13	0.144	0.287	-0.081	0.041	-0.200	-0.122	-0.125
14	0.598	-0.006	-0.022	0.050	-0.022	0.021	-0.074
15	0.621	-0.269	0.011	0.054	0.031	-0.037	-0.020
16	0.291	-0.050	-0.010	-0.086	0.012	0.099	0.023
17	0.162	0.079	0.087	0.348	-0.115	0.027	-0.038
18	0.504	-0.245	0.140	0.023	0.074	-0.060	-0.028
19	0.345	-0.055	0.011	0.283	0.148	0.140	-0.034
20	0.239	-0.034	0.013	0.126	-0.026	-0.115	-0.001
21	0.319	0.151	**-0.726**	0.028	0.146	-0.009	-0.098
22	0.180	-0.035	-0.013	**-0.443**	-0.280	0.087	0.034
23	0.354	0.020	-0.050	-0.021	-0.007	0.007	0.039
24	0.157	0.025	-0.234	-0.110	-0.169	-0.075	0.095
25	0.117	0.043	0.071	0.012	0.084	0.175	0.020
26	0.126	0.011	0.015	0.036	-0.151	0.008	0.001
27	**0.597**	0.129	-0.102	-0.087	-0.258	0.027	0.086
28	0.105	0.050	0.060	-0.046	0.156	0.100	0.023
29	0.158	0.032	0.007	0.108	0.069	-0.079	-0.187
30	0.122	0.038	0.009	0.028	-0.036	0.116	0.081
31	0.111	0.040	0.041	-0.067	-0.022	-0.008	0.045
32	0.332	0.171	0.131	-0.120	0.047	-0.017	0.049
33	0.089	0.019	0.016	0.006	-0.120	-0.063	0.014
34	0.217	-0.018	-0.010	-0.076	0.024	0.317	-0.131
35	0.167	0.070	0.070	-0.040	0.003	0.021	0.056
36	0.087	0.031	0.025	-0.082	-0.070	-0.262	-0.247
37	0.139	0.121	-0.047	0.229	**-0.712**	-0.007	0.051
38	0.134	**-0.705**	-0.627	0.035	0.006	-0.010	0.021
39	0.391	-0.203	**0.595**	0.002	-0.026	0.017	-0.008
40	0.136	0.052	-0.001	0.064	0.189	-0.225	**0.429**
41	0.315	0.006	0.021	0.206	-0.088	0.109	0.184
42	0.223	-0.063	-0.074	-0.044	0.005	-0.022	-0.025
43	0.258	-0.020	-0.043	0.001	0.001	-0.002	-0.004
44	0.097	-0.038	-0.045	-0.032	0.012	-0.013	-0.036
45	0.384	0.066	0.087	-0.082	-0.111	0.028	0.020
46	0.286	0.060	0.045	0.187	0.046	-0.021	-0.251
47	0.138	0.035	0.053	0.123	0.025	0.171	-0.057
48	0.683	0.021	0.032	-0.238	0.063	-0.001	-0.137
49	0.114	0.048	-0.016	0.052	0.102	**0.361**	0.343
50	0.341	0.073	0.023	0.181	0.080	0.005	0.069
51	0.349	0.094	0.087	0.129	0.178	-0.070	-0.010
52	0.146	0.034	0.022	-0.001	0.032	0.093	0.117
53	0.066	0.025	0.040	-0.087	-0.115	0.308	-0.003
54	0.050	0.013	0.041	0.044	0.014	-0.075	0.052
55	0.068	0.014	0.045	-0.043	0.007	-0.007	0.184
56	0.060	0.028	0.025	-0.013	-0.092	-0.068	-0.011
57	0.076	-0.087	0.030	-0.001	-0.013	0.010	0.008
58	0.064	0.020	0.052	-0.065	-0.010	-0.152	0.035
59	0.086	0.023	0.057	0.070	0.096	-0.200	-0.231
60	0.146	0.040	0.009	-0.139	0.064	-0.058	-0.031
61	0.254	0.072	0.053	0.012	0.027	-0.060	-0.273
62	0.094	0.032	0.031	-0.063	0.070	0.096	-0.063
63	0.075	0.021	-0.020	-0.197	0.051	0.201	-0.120
64	0.172	0.021	0.040	-0.184	0.069	-0.343	0.315
65	0.096	0.020	0.031	-0.071	0.000	-0.261	-0.015

Figure 6: Multisectoral effect of demand policy control 1

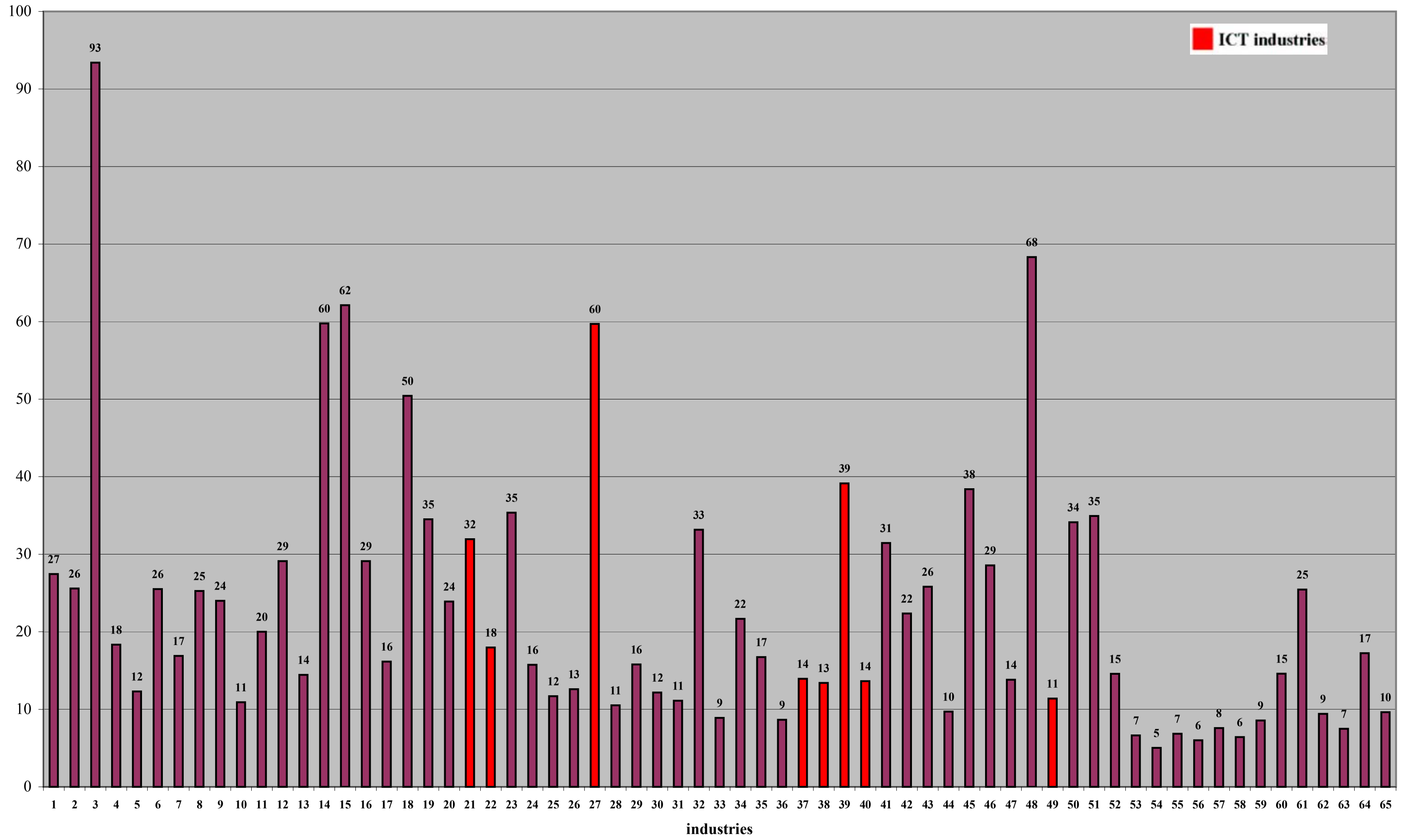

Figure 7: Structure of the policy control 1

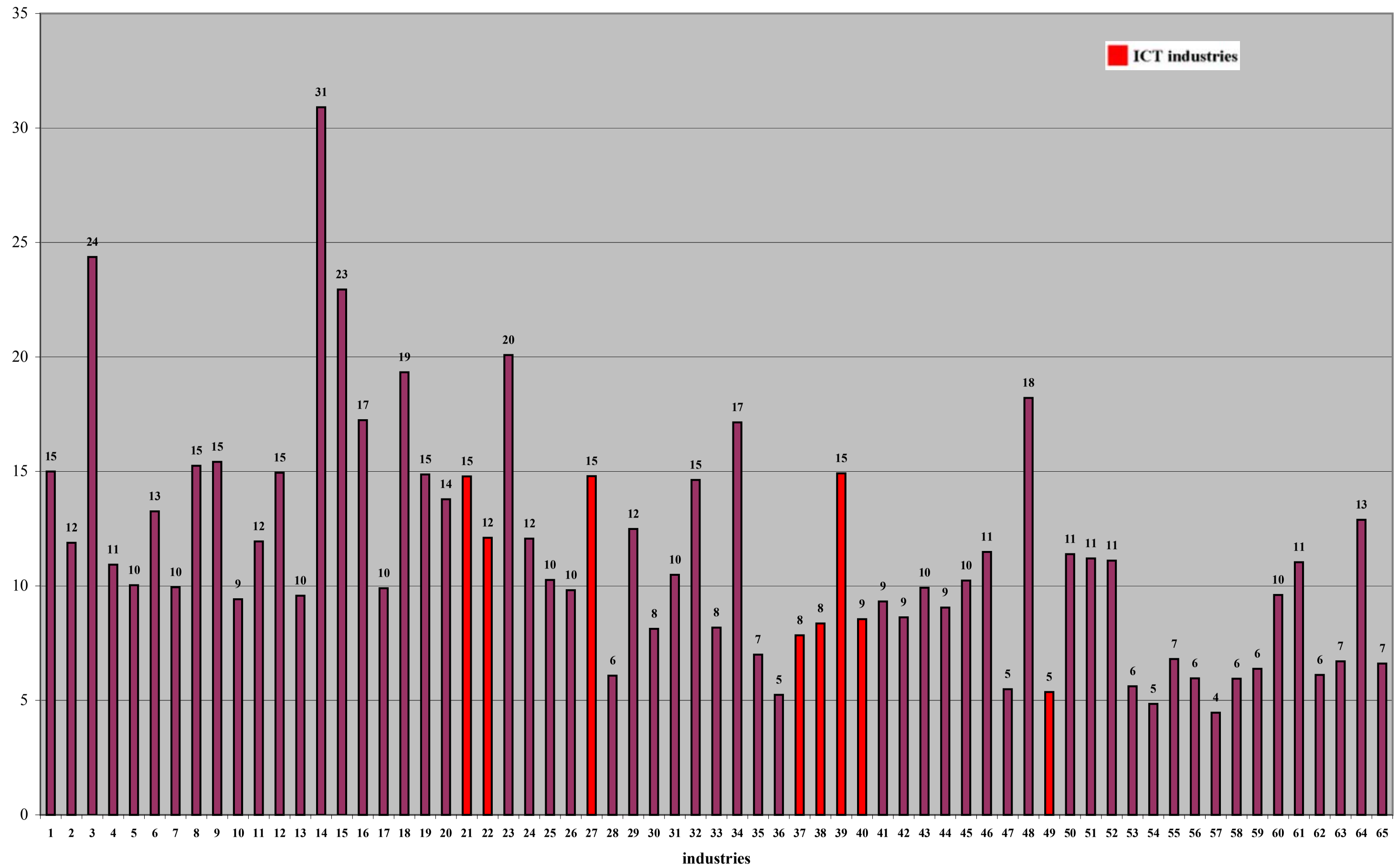

Figure 8: Multisectoral effect of "Computer and electronic products" policy control 12

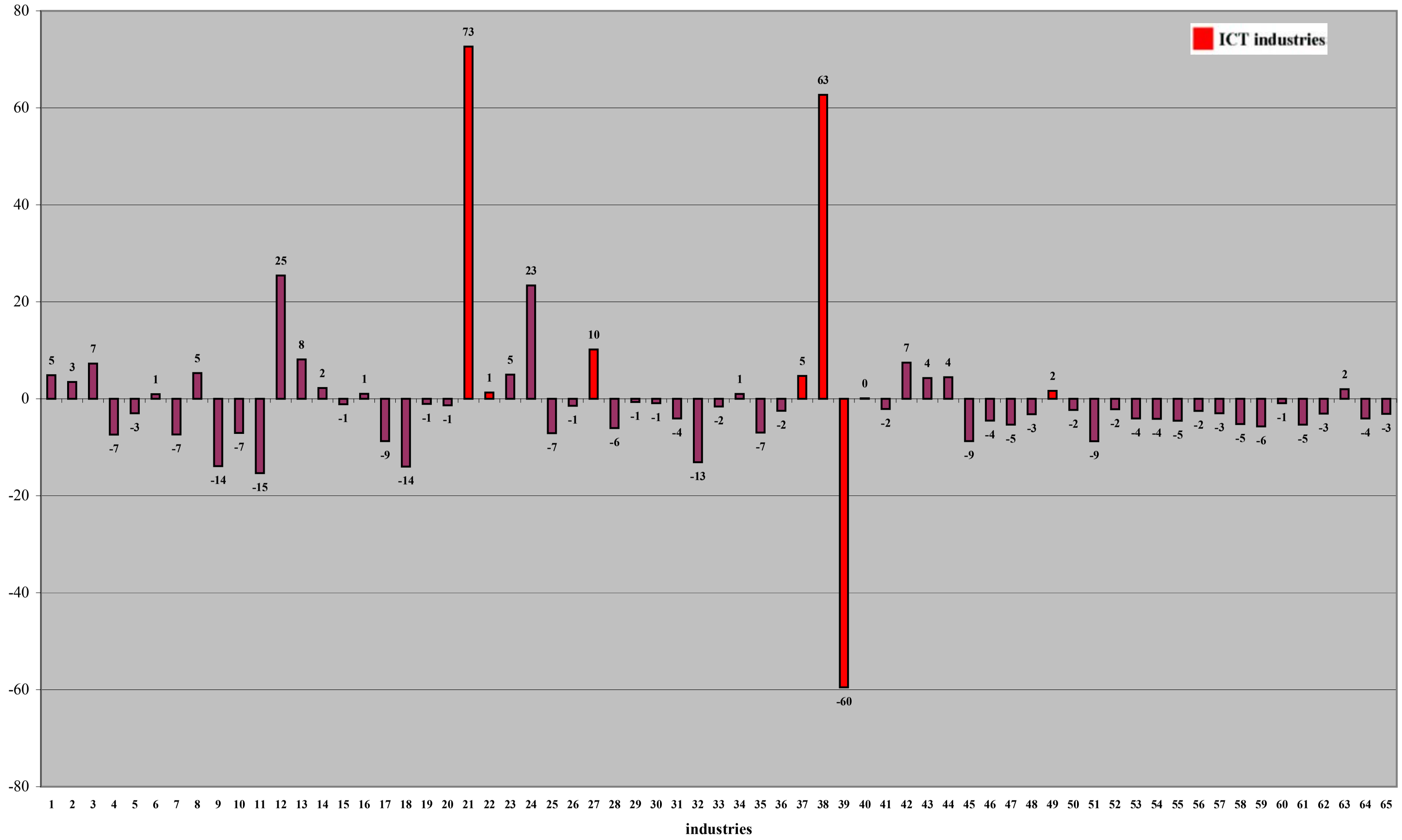

Figure 9: Structure of the policy control 12

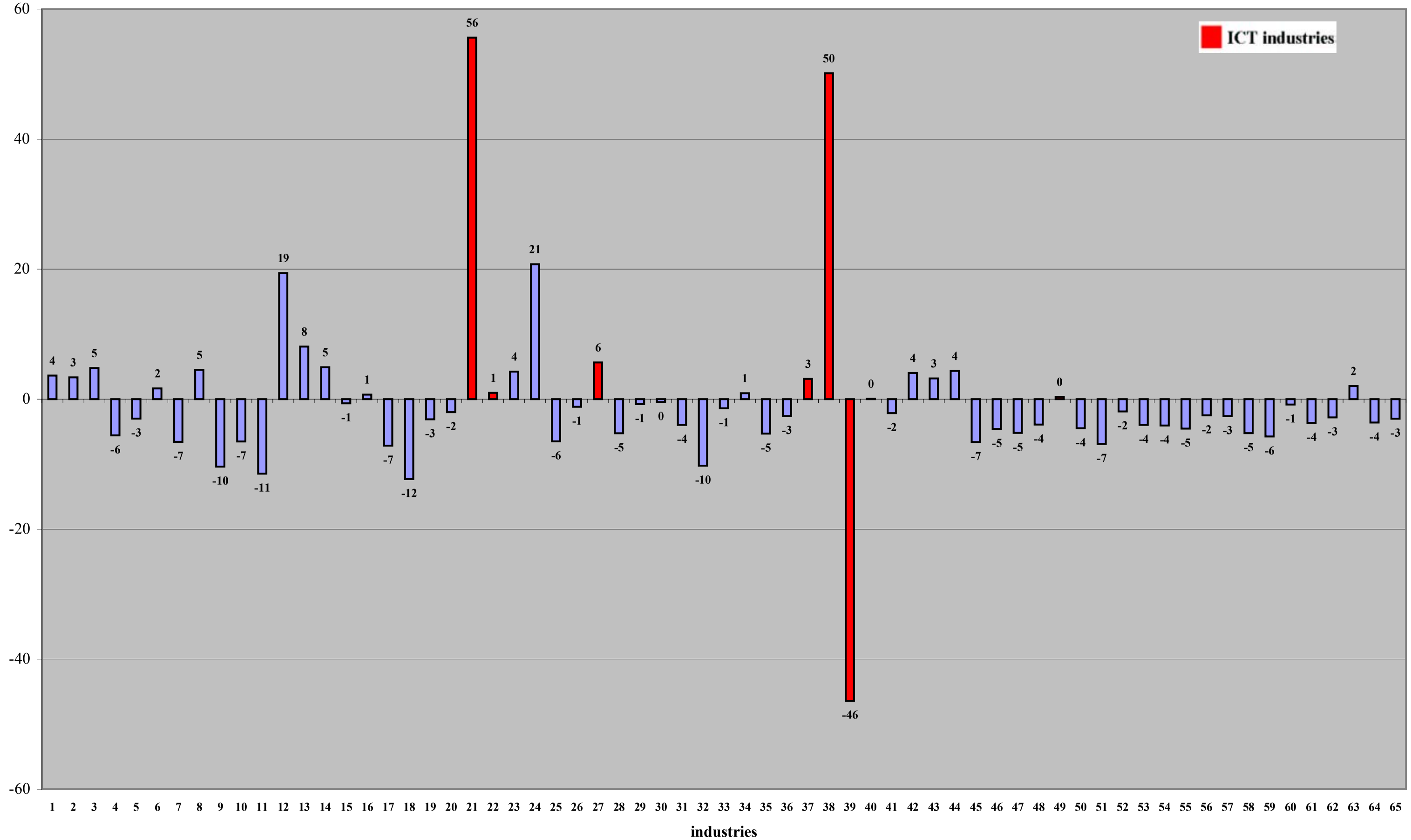

Figure 10: Percentage share of policy and moduli combination $12-1$

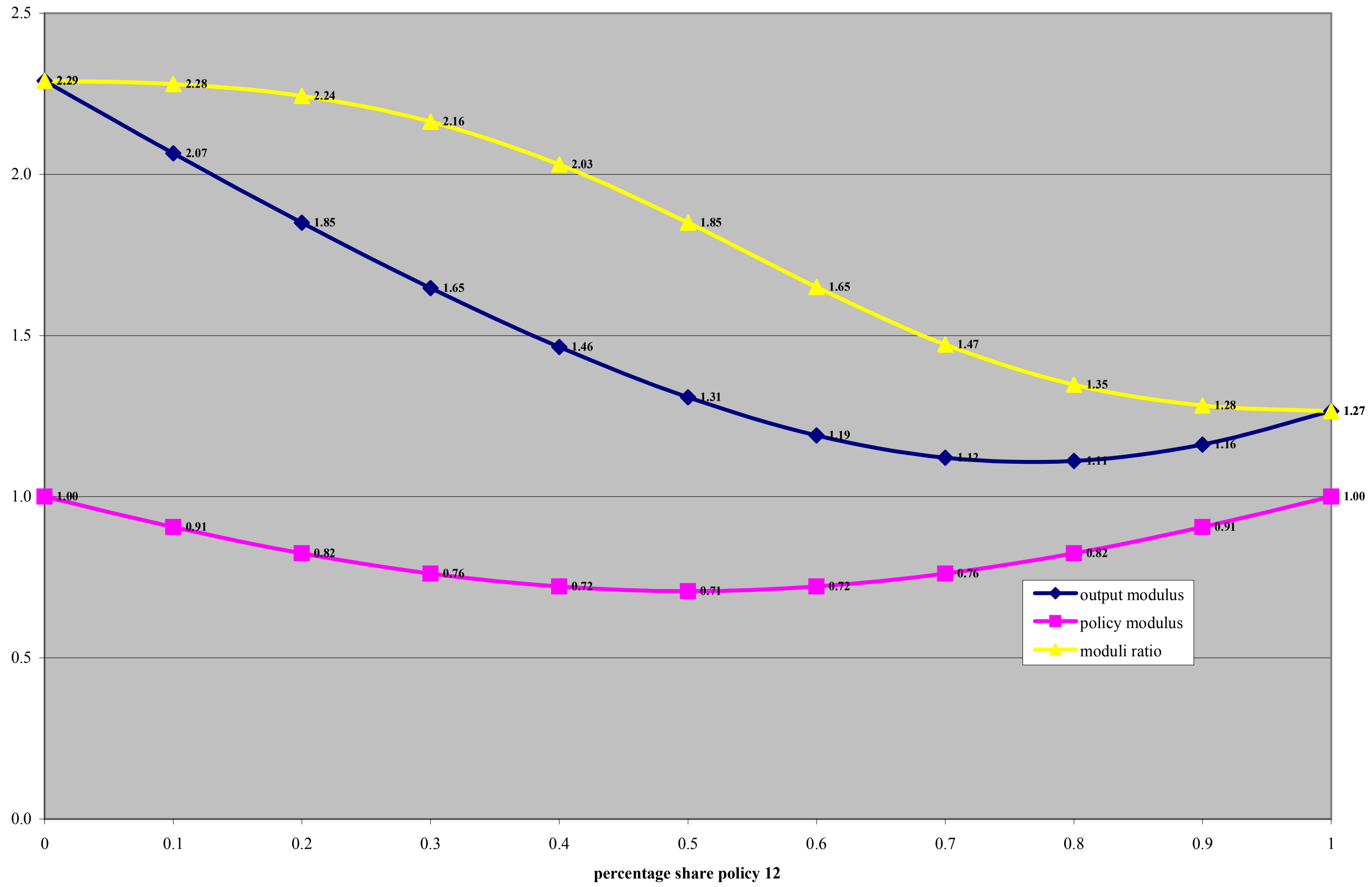

Figure 11: Multisectoral effect of the combination of demand policy control 12 and 1 (weights 0.2, 0.8)

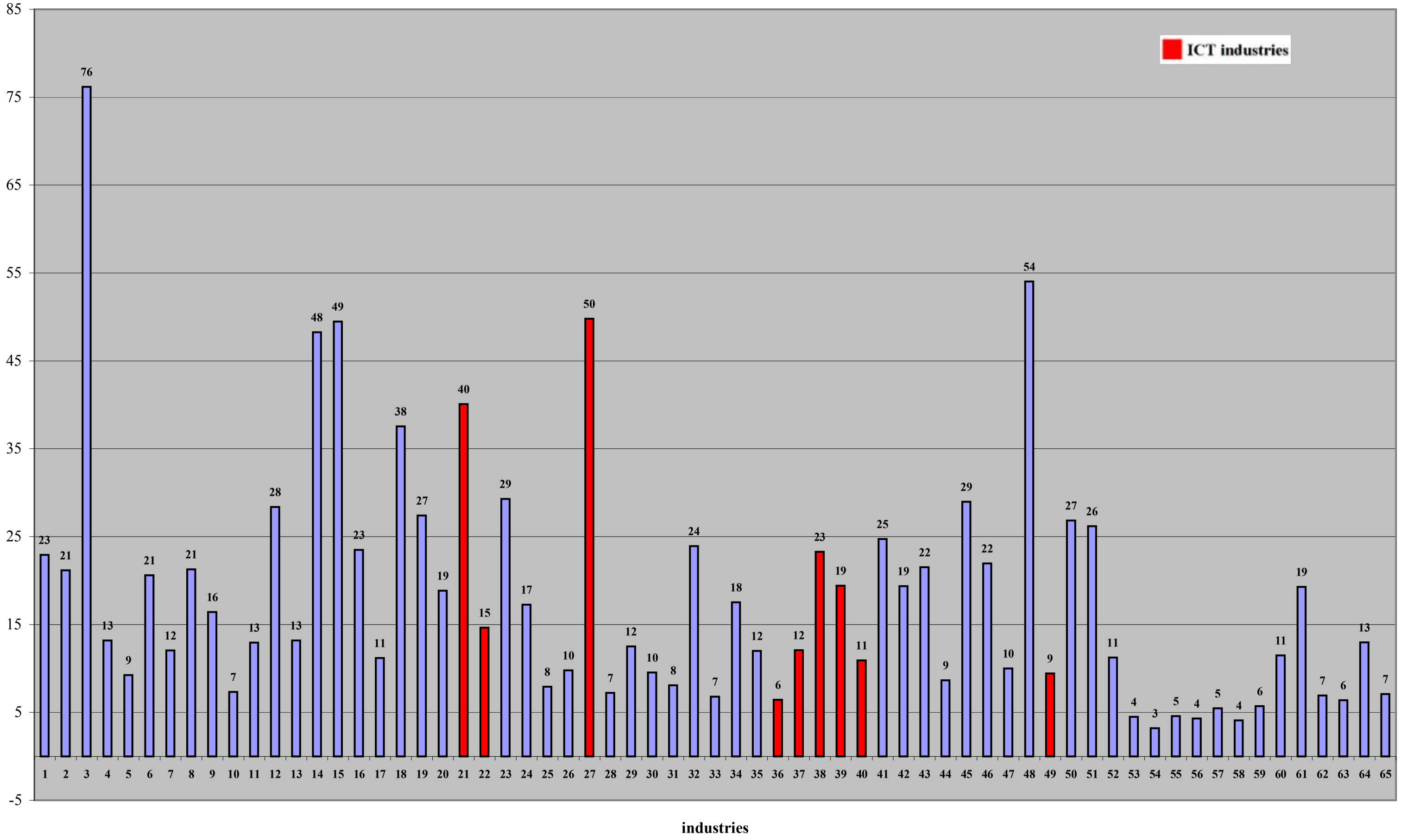

Figure 12: Structure of the wine policy control 12 and 1 (weights 0.2 for policy 12 and 0.8 for policy 1)

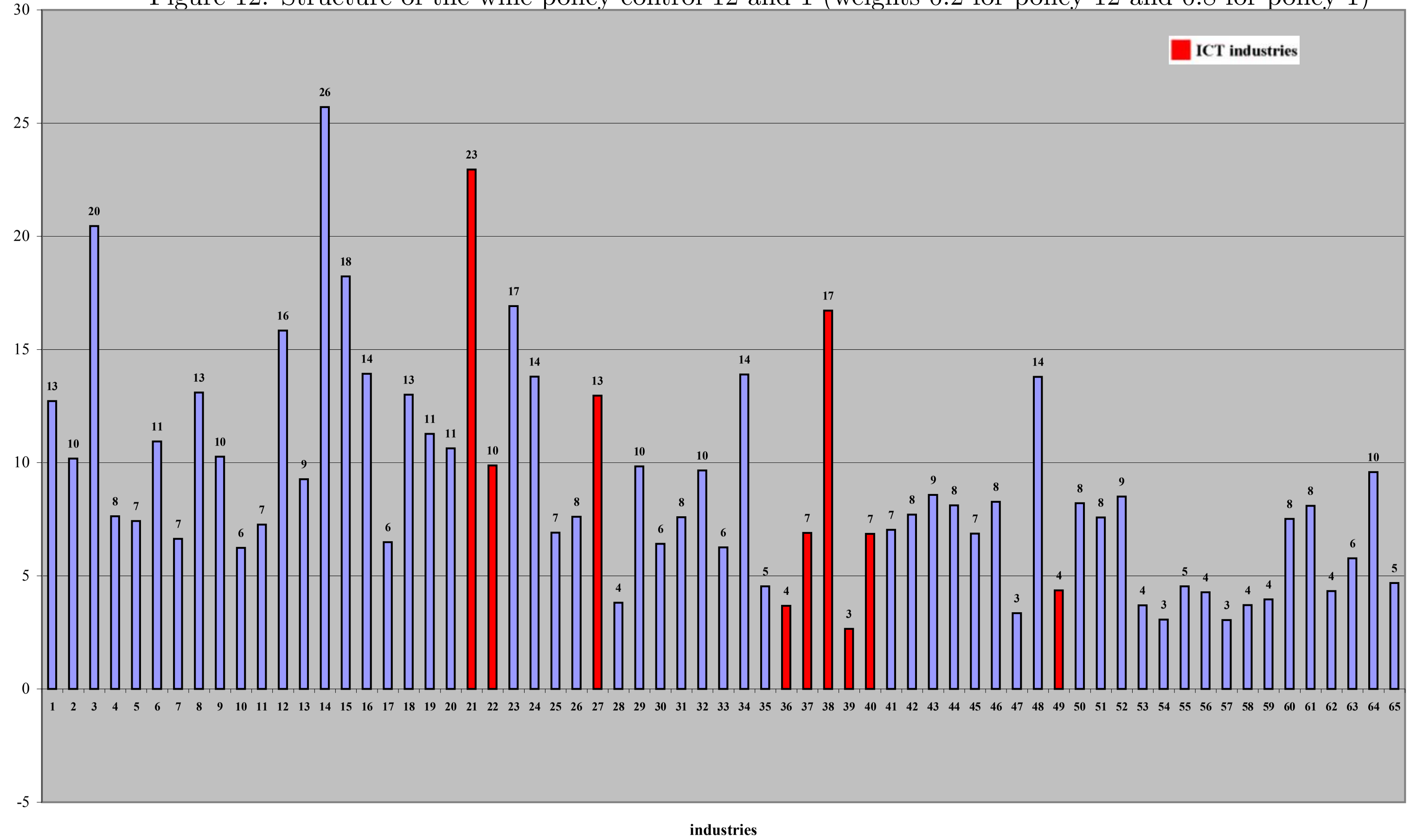

Table 4: Policy 12 (”Computer and electronic products”)

	ICT industries	output $s_{12} \cdot \mathbf{u}_{12}$	input $\mathbf{v}_{12}$
21	Computer and electronic products	73	56
22	Electrical equipment, appliances, and components	1	1
27	Wholesale trade	10	6
37	Publishing industries (includes software)	5	3
38	Motion picture and sound recording industries	63	50
39	Broadcasting and telecommunications	-60	-46
40	Information and data processing services	0.11	0.06
49	Computer systems design and related services	2	0.36
	total ICT effect	94	70
	totale output effect	-7	-24

Table 5: Results of structures combination policies 12-1

Coefficients		Modulus	Modulus		21	ICT	total
a_2	a_1	$\|\|s\mathbf{u}\|\|$	$\|\|\mathbf{v}\|\|$	$\|\|s\mathbf{u}\|\|/\|\|\mathbf{v}\|\|$	output	output	output
1	0	127	100	1.27	73	94	-7
0.9	0.1	116	91	1.28	69	105	142
0.8	0.2	111	82	1.35	65	115	292
0.7	0.3	112	76	1.47	60	126	441
0.6	0.4	119	72	1.65	56	137	591
0.5	0.5	131	71	1.85	52	147	740
0.4	0.6	146	72	2.03	48	158	889
0.3	0.7	165	76	2.16	44	169	1039
0.2	0.8	185	82	2.24	40	180	1188
0.1	0.9	207	91	2.28	36	190	1338
0	1	229	100	2.29	32	201	1487

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