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by

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Evolutionary Micro-dynamics and Changes in the Economic Structure *

André Lorentz† and Maria Savona‡

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Abstract

The paper aims to account for the empirical stylised facts related to changes in sectoral structures that have led to the growth of services in most advanced countries over recent decades. A growth model with evolutionary micro–founded structural change is developed, which formalises the role of technical change and changes in intermediate demand as they affect the evolution of the sectoral composition of the economy and macro-economic growth. Firstly, we provide a micro–foundation for the Kaldorian Cumulative Causation mechanism. Secondly, we account for (demand–related) macro-constraints affecting the micro-behaviour of firms in the decision to adopt technology. We also formalise the mechanisms transmitting the effects of micro-behaviour on aggregate growth, via changes in the intermediate linkages and sectoral composition of the economy. The simulated results are based on the use of the actual data, including Input–Output (I–O) coefficients in the case of Germany. Three scenarios are identified, which account for the effects of a set of key parameters on changes in the structure of the economy.

Keywords: Economic Growth, Structural change, Growth of Services, Evolutionary Micro–foundation, Input–Output
JEL classification: E11, L16, O14, O33, O41

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1 Introduction

The debate around the determinants and economic impact of tertiarisation is age–old (Fisher, 1935; Clark, 1940; Fisher, 1945) and has always been somewhat controversial. On the one hand, the 'optimists', (for instance Fourastié, 1949), looked at the growing employment share of services as being an indicator of a further stage of development in advanced economies following mass industrialisation as well as a symptom of an increasing income– and consumption– capacity. On the other hand, a later, large community of 'sceptical' scholars (Baumol and Bowen, 1966; Baumol, 1967; Kaldor, 1966; Fuchs, 1968), pointed to the 'collateral effects' of the growth of services in terms of de–industrialisation, which translated into (s)lower aggregate productivity growth.

Since the beginning of this debate, the growth of services has become an empirical stylised fact, which represents *de facto* the most relevant case of change in the economic structure (for a recent reassessment, see Parrinello, 2004; Schettkat and Yocarini, 2006). Yet, it is still the object of lively debate, especially between the enthusiasm raised by the literature on the 'New Economy' and the role of information and communication technologies (ICTs) (among many others OECD, 2000; van Ark, Inklaar, and McGuckin, 2002), and the cautious approach of the Baumolian scholars.

A recent collection of contributions on the economics of services (ten Raa and Schettkat, 2001) in fact refers to the 'service paradox' as a still unresolved issue in the economic literature (see also Appelbaum and Schettkat, 1999; Baumol, 2001; Pugno, 2006). The 'paradox' consists of the empirical fact that advanced economies are still experiencing sustained growth rates in real output and employment, in the service industries, despite the trends towards increasing input costs and prices.

Baumol recently confirmed his position with respect to the 'service paradox' (p.1 Baumol, 2008):

> I have repeatedly argued that the rising real prices that constitute the cost disease that is named in my honour cannot force society to give up the patterns of consumption to which it is habituated and that it prefers now or used to. Neither health care nor education are condemned to deterioration in quality and decline in quantity by their rising real prices. For the nearly universal phenomenon of rising productivity means we *can* afford them, indeed, that we can even afford steady expansion in the amounts supplied and consumed, despite their disturbingly persistent and substantial rates of cost increase.

Further, he (Baumol, 2008) points to the very essence of the process of structural change – cross-sectoral differences in productivity growth rates –

by reformulating the concept of 'cost disease' named in his honour in terms of 'Baumol's Fourth Tautology'

> 'Since rates of labour–saving productivity growth are uneven, the growth in some activities *must* be below average'

Baumol refers to the two specific empirical facts that represent the main drivers of tertiarisation processes. On the one hand patterns of (final) consumption of services have been shown to be rather price–inelastic. On the other hand, the uneven rate of productivity gains across sectors are behind the existence of a 'paradox'.

Indeed, since the debate around tertiarisation started, the growth of real output shares in services has been mainly attributed to shifts in private domestic consumption, which in turn has been claimed to be mainly sustained by a positive income effect, more than compensating for a negative price effect. However, the demand for services overall has been steadily growing, whereas average real income growth rates have been slightly declining from the mid–1970s onwards (ten Raa and Schettkat, 2001). As a consequence, ten Raa and Schettkat (2001) refer to what they call a more general 'change in demand conditions', which is claimed to dominate over the pure (final) income and price effects, in driving the 'service paradox'.

The 'service paradox', and particularly the black box of the 'change in demand conditions' is likely to be related to changes in the composition of intermediate demand for services. These latter follow changes in the inter–industry division of labour between services and the rest of the economy. Changes in intermediate links might complement — and in some case dominate — the role of income– and price–led changes in final demand in accounting for the structural change leading to the growth in services. The 'change in demand conditions' – namely the role of intermediate demand – is argued here to be overlooked in the Baumolian and post–Baumolian literature devoted to the determinants and effects of the growth in services.

More generally, much effort has been devoted in the empirical literature to identification of the sources of structural change, particularly in the contributions in the Input–Output (I–O) tradition, starting with Leontief (1951) and Leontief (1953) seminal works. Within the I–O framework, and in the economic literature more generally (Pasinetti, 1973; Pasinetti, 1981), a full empirical account of structural economic change relies on the assessment of changes in sectoral interdependencies.

In line with this literature, in earlier work (Savona and Lorentz, 2005) we decomposed sectoral output growth into the relative contribution of changes in intermediate coefficients and final domestic and foreign demand. We applied an I–O Structural Decomposition Analysis (SDA) technique (for an exhaustive review see Rose and Casler, 1996) to 13 selected macro–branches of the economy over the period from end 1960s to end 1990s for four OECD countries (Germany, Netherlands, UK and US).

The empirical evidence thereby identified can be summarised as follows:

1. Real output growth since the beginning of the 1970s in most of the OECD countries has been positive for most of the service branches considered, and particularly for the Knowledge Intensive Business Services (KIBS)[1]. Further, this seems not to have crowded out the manufacturing branches, except in the UK and USA, between the end of the 1970s and the beginning of the 1980s. This is in fact the only sub-period for which a phase of de-industrialisation seems to emerge, although confined to the UK and USA.

2. The contribution of changes in intermediate coefficients to real output growth is much higher for service than manufacturing branches. The sources of structural change leading to growth in services are linked to both intermediate and final demand, whereas the output growth of manufacturing branches is mainly due to final (private and public) consumption. Unlike what has occurred in manufacturing branches, foreign demand has played a marginal role in the output growth of services, and this trend continued in the 1990s.

3. As far as the branch of KIBS is concerned, the strong dynamics of real output growth have been sustained, not only by final demand, but also and particularly by the dramatic changes in the coefficients of intermediate demand. This confirms that the growth of KIBS represents the most important case of structural change driven by intermediate demand.

Our empirical findings are in line with those in recent work on the relative contribution of KIBS to aggregate performance, in terms of both output and productivity growth (van Ark, Inklaar, and McGuckin, 2002; Peneder, Kaniovsky, and Dachs, 2003; Cainelli, Evangelista, and Savona, 2006; Kox and Rubalcaba, 2007). This supports our main conjecture that the role of changes in intermediate demand, and inter–sectoral linkages, in driving the most dramatic changes in the sectoral structure of developed economies, has been overlooked throughout the long debate on tertiarisation, and particularly within the Baumolian literature.

[1] The term KIBS was first coined by Miles (1994) and variously reprised (among others Miles, Kastrinos, Bilderbeek, and den Hertog, 1995; Gallouj, 2002). For a detailed list of the sectors considered as KIBS, see Table 2 in the Appendix

The present work aims to reconcile the two–sided extended debate on the determinants of tertiarisation, by considering the 'Baumol's disease' as one possible – and time–specific – scenario, among others. To do so, we start from the 'service paradox' and the empirical stylised fact identified above, and account for the main sources of structural change of the economy by considering the role of technological change and changes in intermediate demand. To achieve this, we develop a formal model of economic growth with evolutionary micro–founded structural change.

The model developed is in line with attempts to embrace, within a unifying framework, both neo-Schumpeterian [2] and Keynesian lines of thoughts in explaining economic growth (Verspagen, 1993; Verspagen, 2002; Verspagen, 2004; Fagerberg, 1994; Montobbio, 2002).

The model extends that proposed in Llerena and Lorentz (2004) by providing an evolutionary micro-foundation for structural change in the economy. Firstly, we provide a micro–foundation for the Kaldorian Cumulative Causation mechanism (Kaldor, 1957; Kaldor, 1966)[3] Secondly, we account for (demand–related) macro-constraints as affecting the micro-behaviour of firms when deciding to adopt technology. Further, we account for the mechanisms transmitting the effects of micro-behaviour on aggregate growth, via changes in the intermediate linkages and sectoral composition of the economy.

More particularly, our model attempts to formally account for the following hypotheses:

1. The growth and composition of final and intermediate demand ultimately shapes the structural changes of sectoral output growth in advanced economies. In particular, at the meso–macro level of analysis and within an Input–Output framework, a predominant role in deter-

[2]The importance of technical change for growth and competitiveness of firms, sectors and countries, emphasised by Schumpeter (1934) has been reprised within the neo-Schumpeterian stream of literature, starting from the seminal contribution by Nelson and Winter (1982) (See also, among others Dosi, Freeman, Nelson, Silverberg, and Soete, 1988; Chiaromonte and Dosi, 1993; Silverberg and Verspagen, 1995). This stream of literature however is characterised by an almost exclusive focus on the nature and economic effects of technology adoption and diffusion at the micro-level of analysis, and neglects both the role of the demand-side determinants of firms' strategic behaviour and the consequences of macro-level demand constraints.

[3]Interestingly, both Verspagen (1993) on the one hand and Llerena and Lorentz (2004) on the other, re-consider the Kaldorian Cumulative Causation mechanism. The former by introducing explicit 'evolutionary' selection processes within a cumulative causation framework. The latter by providing a micro-foundation of the process of emergence and diffusion of technologies. We refer the reader to both these contributions for a more detailed discussion of the use of the Kaldorian Cumulative Causation within the neo–Schumpeterian models.

mining the growth of services must be attributed to the increase in demand for services as intermediate inputs for the whole economy (including services themselves);

2. Final demand and technology are self-reinforcing in determining the growth dynamics of firms, whereas intermediate demand factors account for the transmission of micro–behaviours into macro–level effects in terms of structural change. At the micro–level of analysis, favourable demand conditions represent a necessary incentive for firms to respond to technological shocks, to innovate and to grow. On the other hand, we argue that the exploitation of technological opportunities is not a sufficient condition for (service) firms and sectors to experience positive growth rates of output and employment.

The remainder of the paper is organised as follows. Section 2 develops a model of economic growth with evolutionary micro–founded structural change. In section 3 we explain the methodology employed to simulate the model (3.1); we identify three simulation scenarios (3.2) and finally we discuss the simulation results, and the coherence between the empirical evidence found for the case of Germany and the simulated results (3.3). Finally, Section 4 summarises the main findings, draws some conclusions and proposes directions for future research.

2 A Model of Evolutionary Micro-Founded Structural Change

2.1 The macro–economic framework

Drawing on an I–O framework (Leontief (1951)), we decompose the sectoral output into three components: intermediate consumption, final domestic consumption and (net) foreign final consumption. The aggregate output is therefore a function of the sectoral structure of the economy, which in turn is determined by the intermediate and final components of demand.

$$\begin{pmatrix} Y_{1,t} \\ \vdots \\ Y_{j,t} \\ \vdots \\ Y_{J,t} \end{pmatrix} = \begin{pmatrix} I_{1,t} \\ \vdots \\ I_{j,t} \\ \vdots \\ I_{J,t} \end{pmatrix} + \begin{pmatrix} C_{1,t} \\ \vdots \\ C_{j,t} \\ \vdots \\ C_{J,t} \end{pmatrix} + \begin{pmatrix} X_{1,t} \\ \vdots \\ X_{j,t} \\ \vdots \\ X_{J,t} \end{pmatrix} - \begin{pmatrix} M_{1,t} \\ \vdots \\ M_{j,t} \\ \vdots \\ M_{J,t} \end{pmatrix} \quad (1)$$

Aggregate demand ($Y_{j,t}$) for each sector j is decomposed in three components: Intermediate consumption ($I_{j,t}$), final domestic consumption ($C_{j,t}$) and net exports ($X_{j,t} - M_{j,t}$).

Intermediate consumption for sector j is defined as the sum of the firms' demand of sector j product and is defined as follows:

$$I_{j,t} = \sum_{k=1}^{J} Y^D_{j,k,t} = \sum_{k=1}^{J} a_{j,k,t} Y_{k,t} \tag{2}$$

where $Y^D_{j,k,t}$ represents the demand for sector j products by the sector k; $Y_{k,t}$ represents the level of production in sector k, and the coefficients $a_{j,k,t}$ are computed as follows:

$$a_{j,k,t} = \sum_{i} z_{k,i,t} a_{j,k,i,t} \tag{3}$$

where $z_{k,i,t}$ represents the market share of firm i belonging to sector k; firms' market shares are defined by the equation 15 and $a_{j,k,i,t}$ represents the coefficient of intermediate consumption of firm i (belonging to sector k) for sector j products.

The vector I_t of intermediate consumption can therefore be represented as follows:

$$\mathbf{I_t} \equiv \begin{pmatrix} I_{1,t} \\ \vdots \\ I_{j,t} \\ \vdots \\ I_{J,t} \end{pmatrix} = \begin{pmatrix} a_{1,1,t} & \dots & a_{1,k,t} & \dots & a_{1,J,t} \\ \vdots & \ddots & & & \vdots \\ a_{j,1,t} & \dots & a_{j,k,t} & \dots & a_{j,J,t} \\ \vdots & & & \ddots & \vdots \\ a_{J,1,t} & \dots & a_{J,k,t} & \dots & a_{J,J,t} \end{pmatrix} \begin{pmatrix} Y_{1,t} \\ \vdots \\ Y_{k,t} \\ \vdots \\ Y_{J,t} \end{pmatrix} \tag{4}$$

Final consumption is a function of the aggregate real income level. Final consumption for sector j ($C_{j,t}$) is a share $c_{j,t}$ of the aggregate real income level:

$$C_{j,t} = c_{j,t} Y_t \tag{5}$$

Real income is linked to real GDP and is given by the sum of sectoral nominal output deflated by the aggregate price index. The level of consumption devoted to each sector j can therefore be expressed as follows:

$$C_{j,t} = c_{j,t} \sum_{k=1}^{J} \frac{p_{k,t}}{\bar{p}_{t-1}} Y_{k,t}$$

where $\bar{p}_{t-1}$ represents the aggregate price index[4]. The vector C_t of final

[4]The price index is computed as:

$$\bar{p}_t = \sum_{k=1}^{J} p_{k,t} \frac{p_{k,t} Y_{k,t}}{\sum p_{k,t} Y_{k,t}}$$

consumption is therefore computed as follows:

$$\mathbf{C_t} \equiv \begin{pmatrix} C_{1,t} \\ \vdots \\ C_{j,t} \\ \vdots \\ C_{J,t} \end{pmatrix} = \begin{pmatrix} c_{1,t}\frac{p_{1,t}}{\bar{p}_{t-1}} & \dots & c_{1,t}\frac{p_{k,t}}{\bar{p}_{t-1}} & \dots & c_{1,t}\frac{p_{J,t}}{\bar{p}_{t-1}} \\ \vdots & \ddots & & & \vdots \\ c_{j,t}\frac{p_{1,t}}{\bar{p}_{t-1}} & \dots & c_{j,t}\frac{p_{k,t}}{\bar{p}_{t-1}} & \dots & c_{j,t}\frac{p_{J,t}}{\bar{p}_{t-1}} \\ \vdots & & & \ddots & \vdots \\ c_{J,t}\frac{p_{1,t}}{\bar{p}_{t-1}} & \dots & c_{J,t}\frac{p_{k,t}}{\bar{p}_{t-1}} & \dots & c_{J,t}\frac{p_{J,t}}{\bar{p}_{t-1}} \end{pmatrix} \begin{pmatrix} Y_{1,t} \\ \vdots \\ Y_{k,t} \\ \vdots \\ Y_{J,t} \end{pmatrix} \quad (6)$$

For each sector the level of imports ($M_{j,t}$) corresponds to a share $m_{j,t}$ of the total domestic demand of the sector ($I_{j,t} + C_{j,t}$). This share can be a proxy for the international competitiveness of the economy. Sectoral net exports are defined as follows:

$$X_{j,t} - M_{j,t} = X_{j,t} - m_{j,t}(I_{j,t} + C_{j,t})$$

Using equations 4 and 6 we define the vector of net exports ($X_t - Mt$) as follows:

$$\mathbf{X_t} - \mathbf{M_t} = \begin{pmatrix} X_{1,t} \\ \vdots \\ X_{J,t} \end{pmatrix} - \begin{pmatrix} m_{1,t}\left(a_{1,1,t} + c_{1,t}\frac{p_{1,t}}{\bar{p}_{t-1}}\right) & \dots & m_{1,t}\left(a_{1,J,t} + c_{1,t}\frac{p_{J,t}}{\bar{p}_{t-1}}\right) \\ \vdots & \ddots & \vdots \\ m_{J,t}\left(a_{J,1,t} + c_{J,t}\frac{p_{1,t}}{\bar{p}_{t-1}}\right) & \dots & m_{J,t}\left(a_{J,J,t} + c_{1,t}\frac{p_{J,t}}{\bar{p}_{t-1}}\right) \end{pmatrix} \begin{pmatrix} Y_{1,t} \\ \vdots \\ Y_{J,t} \end{pmatrix} \quad (7)$$

By substituting equation 4, 6 and 7 in equation 1, we obtain the following expression for the vector of sectoral demand:

$$\begin{pmatrix} Y_{1,t} \\ \vdots \\ Y_{j,t} \\ \vdots \\ Y_{J,t} \end{pmatrix} = \begin{pmatrix} \alpha_{1,1,t} & \dots & \alpha_{1,k,t} & \dots & \alpha_{1,J,t} \\ \vdots & \ddots & & & \vdots \\ \alpha_{k,1,t} & \dots & \alpha_{j,k,t} & \dots & \alpha_{k,J,t} \\ \vdots & & & \ddots & \vdots \\ \alpha_{J,1,t} & \dots & \alpha_{1,k,t} & \dots & \alpha_{J,J,t} \end{pmatrix} \begin{pmatrix} Y_{1,t} \\ \vdots \\ Y_{k,t} \\ \vdots \\ Y_{J,t} \end{pmatrix} + \begin{pmatrix} X_{1,t} \\ \vdots \\ X_{j,t} \\ \vdots \\ X_{J,t} \end{pmatrix} \quad (8)$$

with

$$\alpha_{j,k,t} = (1 - m_{j,t})(a_{j,k,t} + c_{j,t}\frac{p_{k,t}}{\bar{p}_{t-1}})$$

We obtain the reduced form of our model from this last equation, assuming the short-run macroeconomic identity holds:

$$\begin{pmatrix} Y_{1,t} \\ \vdots \\ Y_{j,t} \\ \vdots \\ Y_{J,t} \end{pmatrix} = \begin{pmatrix} 1 - \alpha_{1,1,t} & \dots & -\alpha_{1,k,t} & \dots & -\alpha_{1,J,t} \\ \vdots & \ddots & & & \vdots \\ -\alpha_{k,1,t} & \dots & 1 - \alpha_{j,k,t} & \dots & -\alpha_{k,J,t} \\ \vdots & & & \ddots & \vdots \\ -\alpha_{J,1,t} & \dots & -\alpha_{1,k,t} & \dots & 1 - \alpha_{J,J,t} \end{pmatrix}^{-1} \begin{pmatrix} X_{1,t} \\ \vdots \\ X_{k,t} \\ \vdots \\ X_{J,t} \end{pmatrix} \quad (9)$$

The vector of sectoral demand, therefore, is obtained as a function of the demand parameters only, given in the short–run (but evolving over time), and of exports. The latter are assumed to be exogenously defined.

2.2 The micro–behaviours

At the micro–level firm output is determined by its share of sectoral demand. The production technology of a firm consists of a combination of products from all sectors (including the one to which the firm belongs) and labour, as defined by the production function (equation 10).

The labour productivity dynamics for each firm are assumed to follow a Kaldor–Verdoorn Law (Verdoorn, 1949; Kaldor, 1966). A technological shock is represented by changes in firms' labour productivity, on the basis of a Kaldor–Verdoorn mechanism and, simultaneously, by changes in the structure of the intermediate coefficients. This allows us to endogenise technical change as having:

- a micro-level effect, on firms' productivity dynamics and market shares;
- a meso-level effect on sectoral production costs and prices;
- a macro-level effect on the structure of the economy via changes in the intermediate coefficients matrix.

A firm i active in sector k is defined by the following production function:

$$Y_{k,i,t} = min\left(\frac{1}{a_{1,k,i,t}}Y^D_{1,k,i,t}, ..., \frac{1}{a_{j,k,i,t}}Y^D_{k,k,i,t}, ..., \frac{1}{a_{J,k,i,t}}Y^D_{J,k,i,t}, A_{k,i,t}L_{k,i,t}\right) \quad (10)$$

The level of production of firm i in sector k is defined as a share $z_{k,i,t}$ of sector k's demand:

$$Y_{k,i,t} = z_{k,i,t}Y_{k,t} \quad (11)$$

The level of demand from firm i for sector j products is therefore defined as follows:

$$Y^D_{j,k,i,t} = a_{j,k,i,t}Y_{k,i,t} \quad (12)$$

The demand for labour expressed by firm i is defined as follows:

$$L_{k,i,t} = \frac{Y_{k,i,t}}{A_{k,i,t}} \quad (13)$$

$A_{k,i,t}$ represents the labour productivity of firm i. As already mentioned, this is assumed to abide by a Kaldor–Verdoorn Law. Labour productivity dynamics are represented as follows:

$$\frac{\Delta A_{k,i,t}}{A_{k,i,t-1}} = \beta_k + \lambda_k \frac{\Delta Y_{k,i,t}}{Y_{k,i,t-1}} \tag{14}$$

The market share of firm i is defined by a replicator dynamic, defined as follows:

$$z_{k,i,t} = z_{k,i,t-1} \left(1 + \phi \left(\frac{E_{k,i,t}}{E_{k,t}} - 1\right)\right) \tag{15}$$

where $E_{k,i,t}$ and $E_{k,t}$ respectively, represent the level of competitiveness of firm i and the average competitiveness in sector k. Each firm's competitiveness level is defined as the inverse of the firm's price level:

$$E_{k,i,t} = \frac{1}{p_{k,i,t}} \tag{16}$$

Firms set prices, applying a mark-up ($\mu_{k,i}$) on their unitary production costs ($\kappa_{k,i,t}$). These latter are defined as:

$$\kappa_{k,i,t} = \sum_{j=1}^{J} a_{j,k,i,t} p_{j,t} + \frac{w_{k,t}}{A_{k,i,t}} \tag{17}$$

where $p_{j,t}$ represents the average price in sector j :

$$p_{j,t} = \sum_i z_{j,i,t} p_{j,i,t}$$

and $w_{k,t}$ is the wage rate applied in sector k at time t. Firms set prices as follows:

$$p_{k,i,t} = 1 + \mu_{k,i} \left(\sum_{j=1}^{J} a_{j,k,i,t} p_{j,t} + \frac{w_{k,t}}{A_{k,i,t}}\right) \tag{18}$$

Wages are set at sectoral level. For a given sector k, the wage dynamic is correlated with sector k productivity[5] growth rate ($\frac{\Delta A_{k,t}}{A_{k,t-1}}$) as well as with the aggregate productivity growth rate ($\frac{\Delta A_t}{A_{t-1}}$). The effect of these two variables on wage dynamics is weighted by the parameter $\nu \in [0; 1]$, such that :

- When $\nu = 1$, the wage dynamics in each sector depend on the macro–level productivity growth rate (i.e. as a centralised wage negotiation system);

[5]With

$$A_t = \frac{Y_t}{L_t} \text{ and } A_{k,t} = \frac{Y_{k,t}}{L_{k,t}}$$

- When $\nu = 0$, the wage dynamics in each sector depend on the sector–level productivity growth rate (i.e. as a sectoral wage negotiation system);

The wage dynamic of sector k is defined as:

$$\frac{\Delta w_{k,t}}{w_{k,t-1}} = \nu \frac{\Delta A_t}{A_{t-1}} + (1-\nu)\frac{\Delta A_{k,t}}{A_{k,t-1}} \tag{19}$$

Note that wage negotiations occur during the period t and the resulting wage level is applied by firms at period $t+1$. Wage dynamics in our model act as a second macro-constraint on firms, as they directly affect firm competitiveness and indirectly affect firms' selection mechanisms. Firms lose competitiveness if their productivity growth rates are slower than the average.

Moreover, $\nu \neq 0$, wage dynamics generate a selection process among sectors. If the sectoral average productivity grows at a slower rate than the average aggregate productivity growth rate, this sector loses competitiveness, due to the wage dynamics mechanism. The amplitude of this effect is a function of the value of the parameter ν.

Technical change at the level of the firm consists of changes in labour productivity as defined by equation 14, and by changes in the coefficient of intermediate demand ($a_{j,k,i,t}$). The changes in intermediate demand coefficients are assumed to be stochastic. Changes in intermediate coefficients are formally represented by the following algorithm:

1. Firms draw a number from a Uniform distribution on [0 ; 1].
2. If this number is contained in the interval $[0 ; \sigma]$, a technological shock occurs. σ is the fixed probability of a technological shock occurring.
3. If a technological shock occurs, every coefficient changes according to the following procedure:

$$a^{'}_{j,k,i,t} = a_{j,k,i,t-1} + \epsilon_{j,k,i,t} \tag{20}$$
$$\epsilon_{j,k,i,t} \sim N(0;\rho) \tag{21}$$

where ρ is a given.

The new set of coefficient $(a'_{1,k,i,t}, ..., a'_{j,k,i,t}, ..., a'_{J,k,i,t})$ as defined by this stochastic process, is introduced in the production function if the potential unitary cost is lower then the actual unitary cost ($\kappa_{k,i,t}$):

$$(a_{1,k,i,t+1}, ..., a_{J,k,i,t+1}) = \begin{cases} (a'_{1,k,i,t}, ..., a'_{j,k,i,t}, ..., a'_{J,k,i,t}) & \text{If } \sum_{j=1}^{J} a'_{j,k,i,t} p_{j,t} < \kappa_{k,i,t} \\ (a_{1,k,i,t}, ..., a_{j,k,i,t}, ..., a_{J,k,i,t}) & \text{Otherwise} \end{cases} \tag{22}$$

A firm exits the market if its market share is below $\bar{z}$. In this case, it is immediately replaced by a firm whose characteristics correspond to the average value of the sectoral characteristics.

The dynamic functioning of the model is therefore based on the following mechanisms, across different levels of analysis:

1. An (exogenous) technological shock translates, at firm level, into lower input costs and prices. These latter increase firms' market shares. An increase in market shares leads to a growth in firms' output. In turn, the Kaldor-Verdoorn mechanism ensures that firms' output growth translates into positive labour productivity dynamics, further lowering costs and prices and further increasing market shares.

2. At the sectoral level, the micro-dynamics affect the structure of intermediate demand and, therefore, the structure of the economy. Changes in the structure of intermediate demand also affect the growth potential of firms (and therefore their potential productivity growth), constraining sectoral demand growth. In other words, meso to micro feedback mechanisms also exist.

3. At the macro-level, growth is a function of (i) the single firm's adoption of technological shocks; (ii) the meso–level diffusion of these shocks and changes in intermediate demand; (iii) changes in the structure of final consumption, in relative prices, and in the employment structure induced at the macro-level by the diffusion of these shocks. In turn, aggregate growth constrains sectoral growth and, consequently, firms' growth potential and labour productivity. Respectively, these changes exemplify macro-to-meso and macro-to-micro feedback mechanisms.

Structural change is the outcome of the co–evolution of these three levels of dynamic and the feedback mechanisms occurring between them.

3 Simulation Results

3.1 Simulation Procedure

We conducted numerical simulations on the model developed in Section 2. The simulation setting is summarised as follows:

- the country specification contains 13 sectors, corresponding to the 13 sectors in the Input–Output Structural Decomposition Analysis carried out in Savona and Lorentz (2005) and reported for convenience in Table 2 in the Appendix;

- each of the sectors includes 20 firms;
- the results presented are the average outcome of a minimum of 50 replications of the simulation setting;
- each simulation runs over 500 steps.

In order to reduce the spectrum of parameters to be analysed, we set the initial structure of the simulation parameters on the basis of the data used in Savona and Lorentz (2005), focusing on the German case. The simulations are carried out on the basis of the actual German OECD STAN (1970–1999) and German OECD I–O tables (1978–1995), at the first time–step, for the following variables and parameters:

- Sectoral intermediate I–O coefficients ($a_{j,k,t}$). Table 3 in the Appendix reports the initial simulation step structure of the intermediate coefficients, drawn from the German Input–Output tables for 1978.
- Sectoral exports ($X_{j,t}$). These figures are drawn from the I–O tables for Germany 1978, and reported in Table 4 in the Appendix.
- Sectoral shares of final consumption ($c_{j,t}$). These are computed as the ratio of sector consumption and total consumption using the 1978 German I–O table. The figures are reported in Table 4 in the Appendix.
- Sectoral shares of import ($m_{j,t}$). These are computed as the ratio of sectoral foreign demand and total demand (final and intermediate) once again using the 1978 German I–O table. These figures are detailed in Table 4 (Appendix).
- Sectoral Kaldor–Verdoorn parameters (β_j and λ_j). These figures are estimated using the OECD STAN (1970–1999) data, also reported in Table 4 [6]

We identify three stylised scenarios based on different parameter settings, and analyse the occurrence of structural change on the basis of each of these scenarios in the case of the simulation specification illustrated above and

[6]The Kaldor–Verdoorn elasticities are estimated over the same time–span (1970–1999) covered by the OECD I–O Tables. We chose to gain in coherence rather than in the actuality of the data with respect to the hypotheses formulated in 1, which refer to the time-span in the I–O tables of 1978–1995.

based on the German data. The scenarios are detailed in section 3.2. It is useful to bear in mind that the objective is not to carry out a proper calibration exercise, as we do not aim to reproduce the trend observed in the data. Rather, we want to investigate whether the results that emerge from the various simulation scenarios are plausible with respect to the empirical evidence, mainly that in Savona and Lorentz (2005), which is in line with other recent contributions (van Ark, Inklaar, and McGuckin, 2002; Peneder, Kaniovsky, and Dachs, 2003; Cainelli, Evangelista, and Savona, 2006; Kox and Rubalcaba, 2007).

We quantify the occurrence of structural change on the basis of the different scenarios in terms of two different dimensions:

1. the degree of concentration, in income (nominal product), real output and employment, measured using an inverse Herfindahl index. This index is intended to measure the unevenness of labour and resources allocations among sectors, as well as changes in the latter due to the mechanisms involved in the various scenarios;

2. the sectoral composition of the economy, in terms of real output and employment. This dimension allows us to analyse the nature of the changes in the structure of the economy generated by the various scenarios.

3.2 Simulation Scenarios

Drawing on the empirical evidence in Savona and Lorentz (2005) and some preliminary simulations, we identify three main scenarios driving structural change, based on changes in intermediate demand [7]. Each of these scenarios corresponds to a specific setting for a number of key parameters. The scenarios considered and the parameter settings upon which they are based can be described as follows.

1. The *"Baumol's disease"* scenario: The structural changes in both the employment and output composition of the economy are driven by the productivity growth differentials among sectors. This scenario emerges as a result of cross-sector differences in the Kaldor–Verdoorn parameters, holding final and intermediate demand constant. These differences

[7] A fourth scenario was initially considered, based on changes in the structure of final consumption. We leave the simulation of this scenario for further research on different country specifications, as the German case shows little change in the structure of final consumption over the period considered.

lead to higher shares of employment in the sectors with lowest productivity growth, and affect the structure of the economy through wage and price dynamics. Structural change based on this scenario emerges if productivity growth differences are not perfectly absorbed by wages, i.e. when the wage setting is centralised. The parameters are set as follows:

(a) the changes in intermediate coefficients are neutralised ($\sigma = 0$);

(b) wages are centralised ($\nu = 1$);

(c) the selection mechanism occurs ($\phi = 1$);

(d) the structure of final demand remains constant (All $c_{j,t} = c_j$).

2. The *"Schumpeterian"* scenario[8]: Structural change is exclusively driven by firms' reaction to technological shocks. The differences in productivity growth rates are neutralised by decentralised wages. The diffusion of the shocks to the economy relies only on the selection mechanism occurring at sectoral level. Structural change is therefore due only to the characteristics of the stochastic processes underlying the changes in the intermediate coefficients and the selection mechanism. The parameters are set as follows:

   (a) the changes in intermediate coefficient occur ($\sigma \neq 0$);

   (b) wages neutralise the differences in sectoral productivity growth rate ($\nu = 0$);

   (c) the selection mechanism occurs ($\phi = 1$);

   (d) the structure of final demand remains constant (All $c_{j,t} = c_j$);

3. The *"Cost reduction"* scenario: Structural change is triggered by both the reaction to technological shocks by firms and the differences in productivity growth rates among sectors. Centralised wage–setting allows these differences to affect both wages and prices and, therefore, production costs. Technological shocks are adopted when they affect production costs. Adoption is therefore biased towards the most productive sectors. In combination with the selection mechanisms, this bias should amplify the effects on structural change as emerge in the "Baumol's disease" scenario. In this case the parameters are set as follows:

[8] Note that here we refer to the Neo-Schumpeterian models considered in Section 1, which consider the technological changes occurring at firm level as being driven by stochastic processes.

(a) the changes in intermediate coefficient occur ($\sigma \neq 0$);

(b) wages are centralised ($\nu = 1$);

(c) the selection mechanisms occur ($\phi = 1$);

(d) the structure of final demand remains constant (All $c_{j,t} = c_j$).

The scenarios rely on a limited number of parameter changes. Modifying the values for σ and ν allows us to consider three different sets of causalities leading to changes in the structure of intermediate demand, i.e. supply– and intermediate demand–led structural changes. The relationship between the parameter settings and the scenarios is summarised in Table 1:

Table 1: *Simulation scenarios*

	$\nu = 0$	$\nu \to 1$
$\sigma = 0$	"Neutral" case	*"Baumol's disease"* scenario:
$\sigma \neq 0$	*"Schumpeterian"* scenario	*"Cost reduction"* scenario

3.3 The case of Germany

This section presents the results obtained from the numerical simulations of the three scenarios detailed above. These are identified on the basis of the initial parameter settings derived from the German data.

The empirical evidence for Germany, as emerging in Savona and Lorentz (2005), shows an increase in the degree of concentration of output, between 1978 and 1995. In other words aggregate output has been growing, but in a small number of sectors.

Figures 1 to 2 respectively present the degree of concentration for income, employment and real output. The figures were obtained for various specifications of the parameters σ and ν, in such a way that they emerge as the effects of the dynamics consequent on the three different scenarios. In particular:

- keeping σ null and moving along the y-axis corresponds to the emergence of a "Baumol's disease" type of dynamics;

- keeping ν null and moving along the x-axis corresponds to "Schumpeterian" type of structural change dynamics;

- modifying simultaneously ν and σ generates a "Cost reduction" type of structural change.

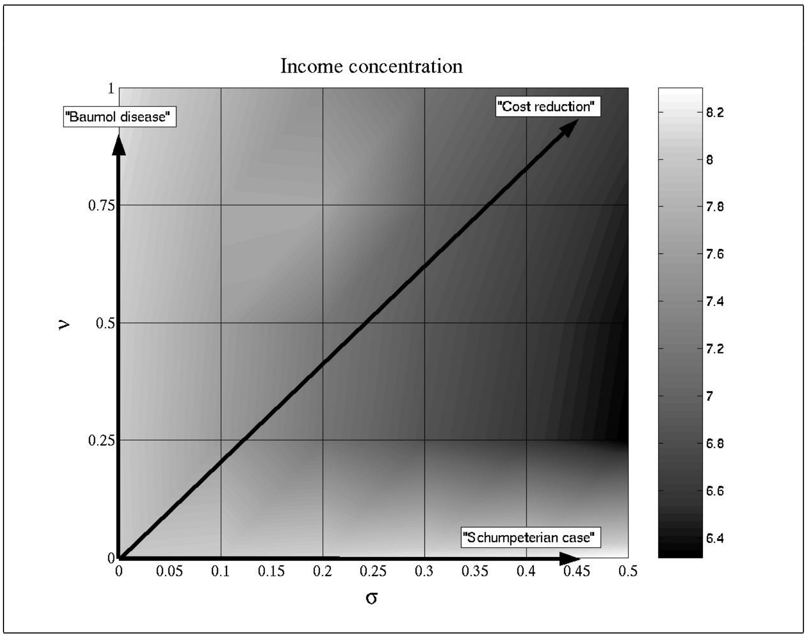

Figure 1: Income sectoral concentration (Inverse Herfindahl index)

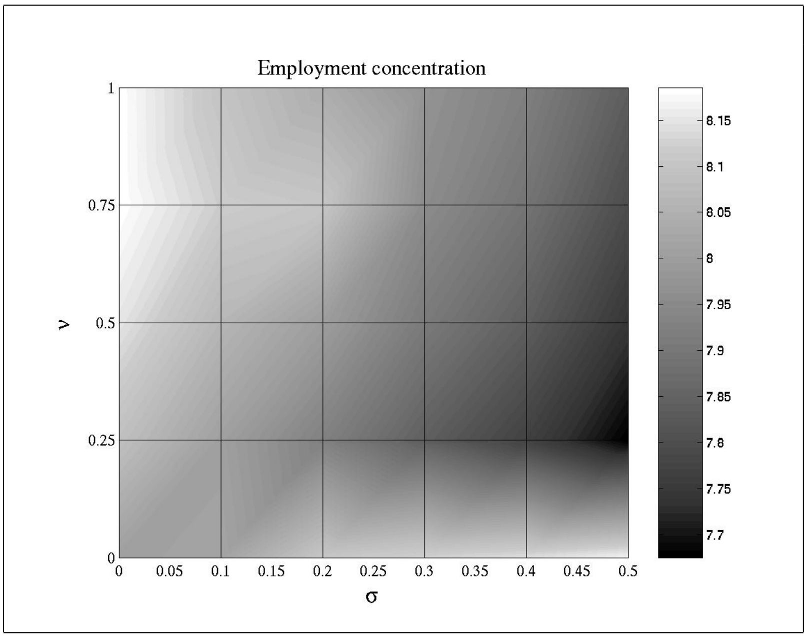

Figure 2: Employment concentration (Inverse Herfindahl index)

As illustrated by Figure 1, in the two extreme cases, the "Baumol's disease" and the "Schumpeterian" ones, the dynamics lead to lower degrees of concentration in income with respect to the "Cost Reduction" or intermediate cases. A similar pattern emerges when considering the concentration in employment (see Figure 2).

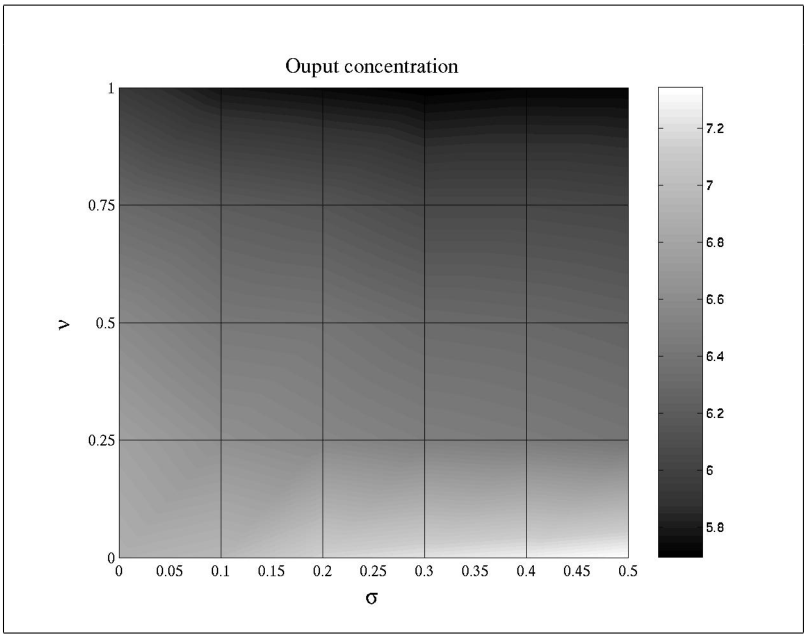

Figure 3: Real output concentration (Inverse Herfindahl index)

Figure 3 presents the concentration levels in terms of output, measured for the various specifications of parameters ν and σ. A dramatic difference is evident with respect to income and employment. As the wage dynamics tend to be more centralised, when keeping the probability of technological shocks to zero, the output concentration, measured at the end of the simulations, becomes higher. Economic activity is therefore more concentrated in the "Baumol's disease" and the "Cost reduction" scenarios while the dynamics considered in the "Schumpeterian" scenario lead to a lower level of concentration (higher dispersion).

These results are confirmed by Figures 4 and 5. In the course of the simulations of the "Baumol's disease" case, the output tends, on average, to be concentrated in a small number of sectors (see Figure 4). This tendency is amplified as wages tend to be more centralised (ν tends to 1). Similar patterns emerge for the "Cost reduction" case. In the "Schumpeterian" scenario, however, the structural changes generated by the simulations lead to lower concentration, or higher value of the inverse Herfindahl index (see Figure 5).

The differences in the outcomes of the three scenarios are less obvious

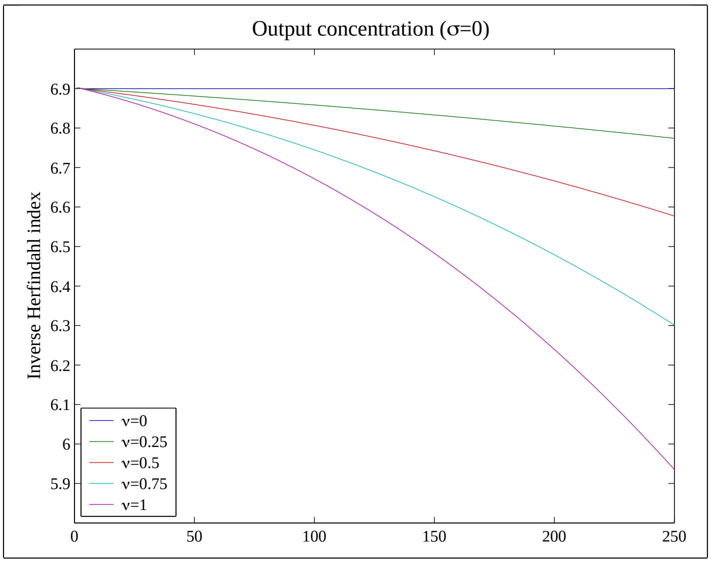

Figure 4: Real output concentration ("Baumol's disease")

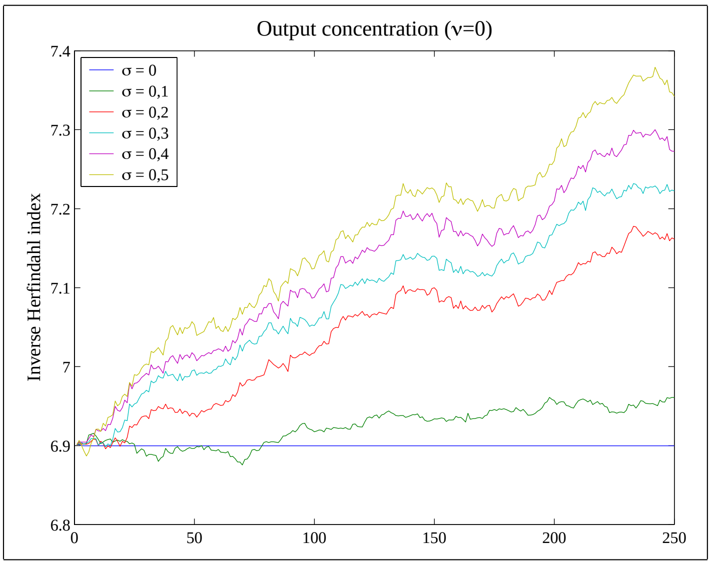

Figure 5: Real output concentration ("Schumpeterian Case")

for employment. In all cases, in the course of the simulations, employment is concentrated in a smaller number of sectors (Figures 6 and 7). The employment dynamics are mainly driven by the productivity dynamics, which explains the similarities in these patterns. Small differences can however be observed: in the "Schumpeterian" case, the more frequent technological shocks slightly slow down the employment concentration (Figure 7). In the

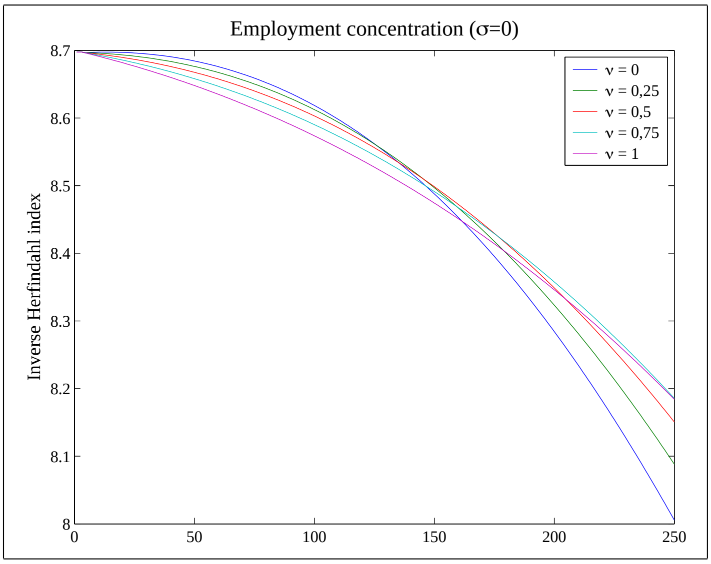

Figure 6: Employment concentration ("Baumol disease")

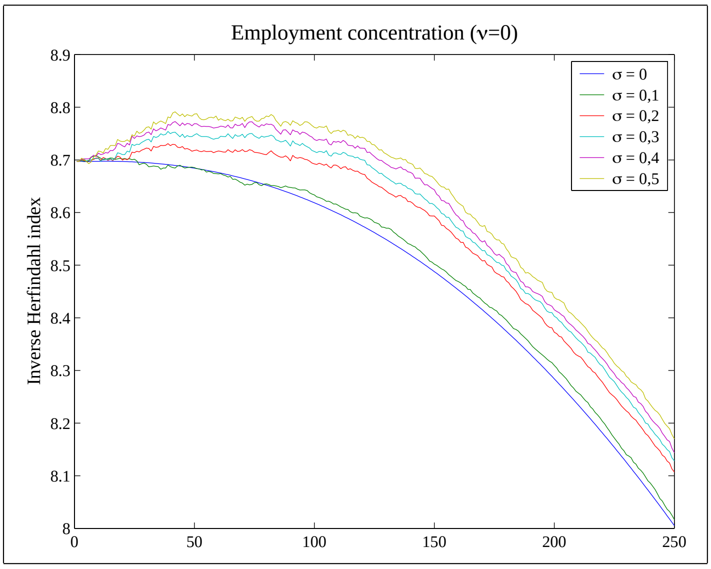

Figure 7: Employment concentration ("Schumpeterian Case")

case of the "Baumol's disease" scenario (Figure 6), and the "Cost reduction" scenario, a higher degree of wage centralisation seems to slightly slow down the concentration process.

We can briefly summarise this first set of findings as follows.

1. In the "Baumol's disease" scenario, structural change dynamics occur

in terms of a lower degree of concentration in the income and employment structures but a higher degree of concentration in the output structure.

2. In the "Schumpeterian" case, structural change results in a lower degree of concentration for all the variables. The economic activity spreads across a larger number of sectors compared to the initial conditions.

3. In the "Cost reduction" scenario, structural change dynamics tend to amplify the initial heterogeneity, deepening the degree of concentration for all the indicators.

These findings can be explained as follows. In the "Baumol's disease" case, structural change is driven only by the differences in productivity dynamics across sectors. As wages are centralised, these productivity differences directly affect the demand structure, *via* the relative prices and the employment structure. Sectors with higher (than average) productivity growth experience a decrease in prices over time and, therefore, an increase in market shares. This explains the growth in the degree of concentration of real output. The high productivity growth sectors increase their levels and shares of output, reducing their costs and prices. The low productivity growth sectors reduce their levels of output as they experience an increase in costs and prices. These two effects compensate for one another, explaining the low degree of concentration in the income structure. Similarly the losses/gains, in output are partially compensated for by the higher/lower, gains in labour productivity, implying a reduction/increase, in the sectoral shares of total employment. This would also account for the lower degree of concentration in the employment structure.

In the "Schumpeterian" case, wages are decentralised and therefore absorb completely the differences in productivity dynamics. The only source of structural change are the technological shocks occurring at the micro-level, which change the technological coefficients. The more frequent the shocks, the more frequent the changes in the structure of intermediate demand. However, the shocks follow similar patterns among sectors. As a consequence, technological shocks tend to reduce the sectoral differences in intermediate demand. Therefore the more frequent the shocks the lower the degree of concentration in output. As wages absorb the changes in labour productivity, price dynamics follow the changes in the technological coefficients. At the meso-level, this implies less concentration in the output and in the income structure. The employment structure of the economy is a direct consequence of the differences in productivity dynamics among sectors, though this effect is slowed down by the technological shocks.

In the “Cost reduction” scenario, structural change is simultaneously due to the differences in the productivity dynamics among sectors and to the technological shocks. In this case, as technological shocks diffuse among the sectors and in the economy, they tend to amplify the sectoral heterogeneity in intermediate demand due to the differences in productivity growth rates. The shocks are absorbed at the micro and meso levels through selection mechanisms, only if these reduce the production costs. The absorbed shocks are those favouring the most productive sectors. Hence, the productivity growth differences affect demand, *via* relative prices, but also through the cost reduction linked to the adoption of technological shocks. In line with the Kaldor–Verdoorn law, the sectors with higher demand growth experience higher productivity growth. The combination of these two mechanisms, therefore, reinforces the concentration dynamics in a small number of highly productive sectors. This last scenario might therefore be the most likely explanation of the increase in concentration found in the empirical evidence.

Figures 8 to 13, present the evolution of the sectoral composition of the economy for each of the scenarios. This allows us to consider in more detail the nature of the structural changes occurring through the various scenarios.

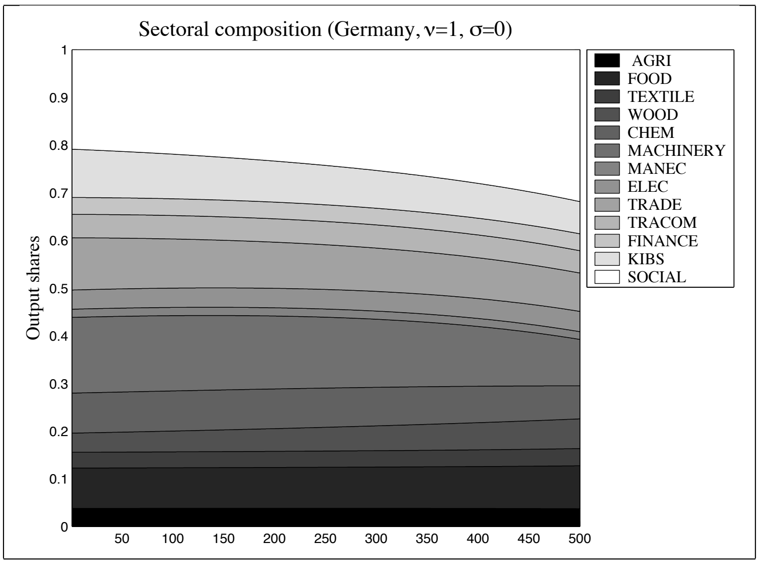

Figure 8: Sectoral composition in real output (“Baumol disease”)

In the “Baumol’s disease” case (Figure 8), except for the SOCIAL sector, all the service sectors, and especially KIBS and TRADE, decline. Manufacturing activities on the other hand, have an increased role in the economy. The manufacturing sectors (especially MACHINERY) together with the SO-

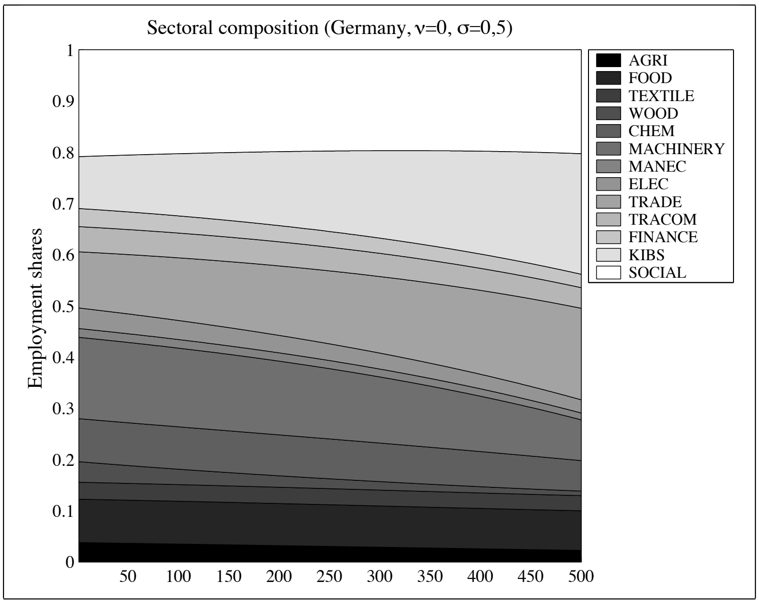

Figure 9: Employment sectoral composition ("Baumol disease")

CIAL sector, experience the highest productivity growth while, as expected, these sectors experience a drastic drop in employment shares (Figure 9). KIBS and TRADE are the two sectors that experience the highest increase in employment shares. The "Baumol's disease" mechanism certainly explains the growth of employment in services. However, structural changes as generated in this scenario lead to a re-industrialisation and a de-tertiarisation of the economy in terms of output created. The mechanisms behind the "Baumol's disease" scenario favour high productivity manufacturing activities, yet they are unable to account for the empirical evidence for the case of KIBS.

Similarly, structural changes in the "Cost reduction" scenario favour manufacturing activities (Figures 10). The changes in the output structure are amplified with respect to the "Baumol's disease" case. Again, the manufacturing branches benefit from the mechanisms underlying this scenario due to the fact that these sectors are characterised by higher productivity growth rates. This result is directly linked to the fact that the dynamics implied in this scenario accelerate and amplify the effects triggered by productivity differences (as in the "Baumol disease" case) or by technological shocks.

In terms of employment, however, slight differences occur. For certain manufacturing activities (especially MACHINERY), the share of employment slightly increases (Figure 11). The growth of output therefore overcompensate for the loss of employment potentially induced by the produc-

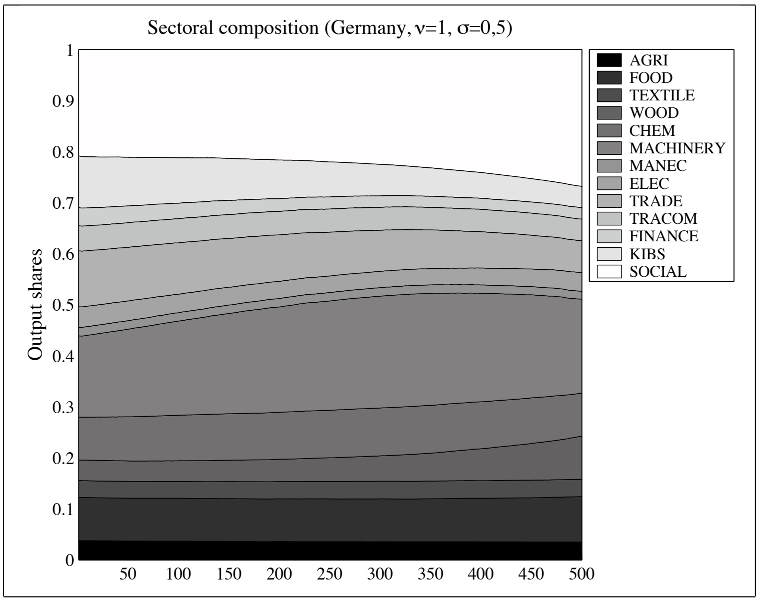

Figure 10: Sectoral composition in real output ("Cost reduction")

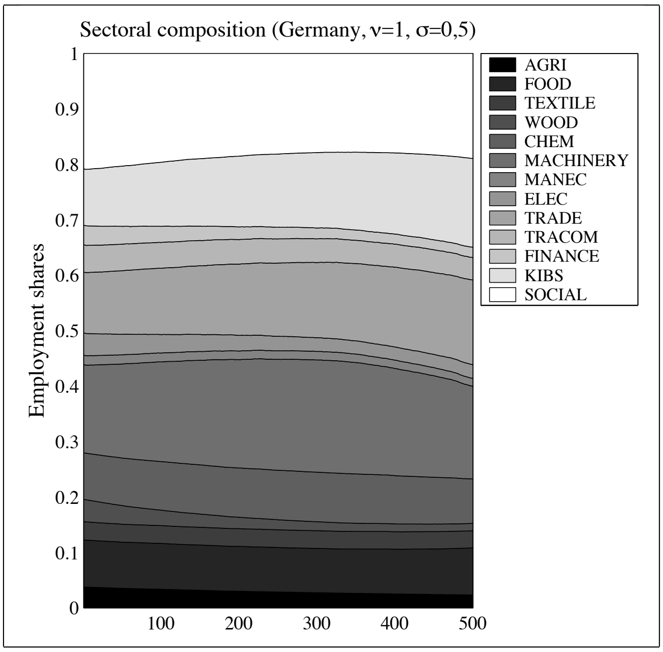

Figure 11: Employment sectoral composition ("Cost reduction")

tivity dynamics.

In the "Schumpeterian" case, structural changes lead to a convergence in

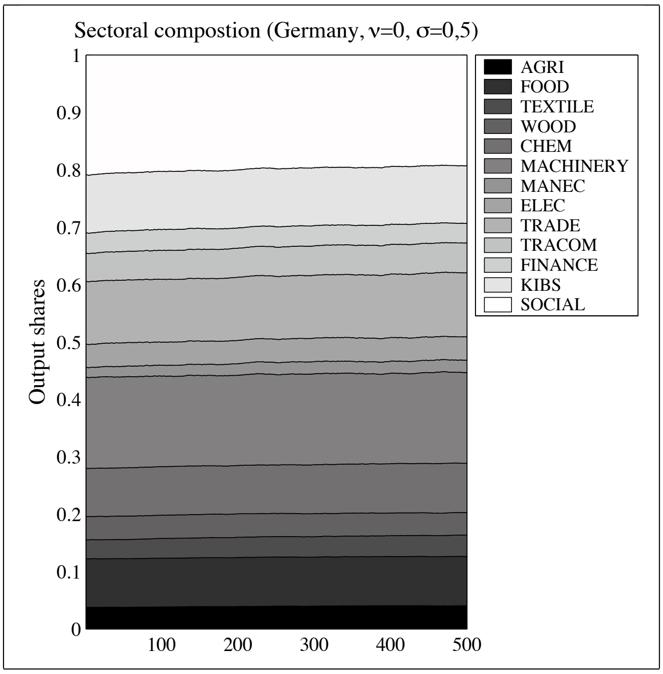

Figure 12: Sectoral composition in real output ("Schumpeterian case")

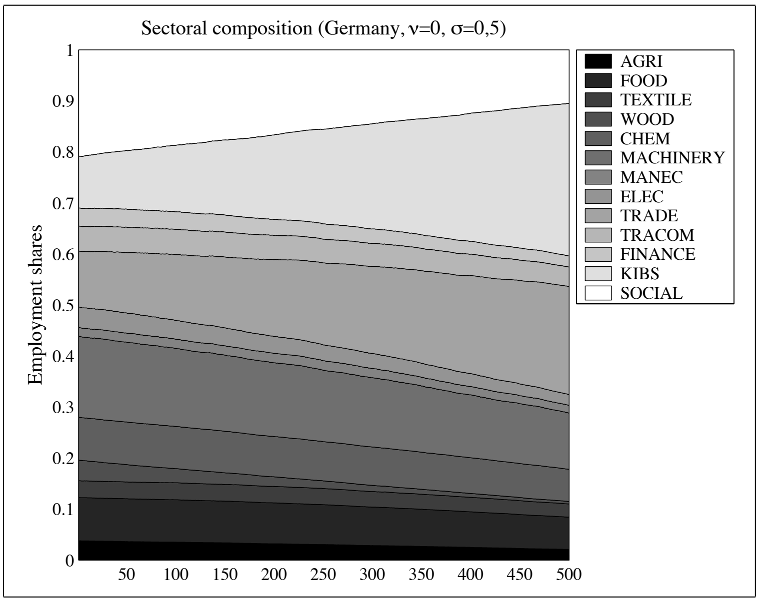

Figure 13: Employment sectoral composition ("Schumpeterian case")

the output share of each sector (Figure 12). This result is directly linked to the symmetry of the technological shocks among sectors. These latter follow the same distribution patterns across sectors.

The structure of employment shows the same trend as emerged in the "Baumol's disease" case (Figure 13). Employment is structured by the productivity differences, as in the above case. As wages are centralised, the effect of the productivity differences is confined to the employment structure.

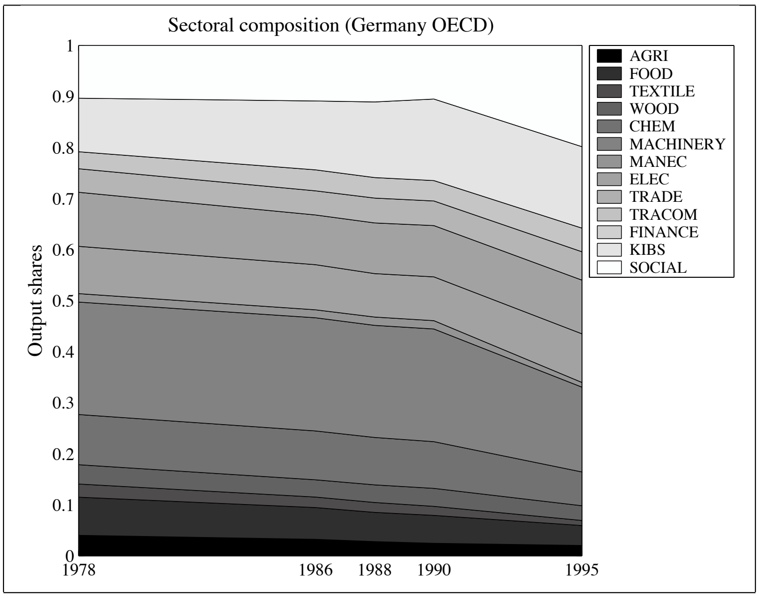

Figure 14: Sectorial composition in real output (Germany 1978-1995)

Figure 14 presents the evolution of the sectoral structure in Germany for the period 1978-1995. There is a clear tendency toward tertiarisation with the rise of KIBS and SOCIAL shares and, more generally, a gain in importance of all the service sectors accompanied by a relative decline in manufacturing activities.

This structure is the opposite to the one generated by the "Baumol's disease" and the "Cost reduction" scenarios. In other words, according to these scenarios, the structural changes generated exhibit a tendency towards industrialisation rather than tertiarisation as observed in the real German data. The two scenarios rely on the existence of productivity differences among sectors. The growth of services in Germany can hardly be completely imputed to productivity growth rate differentials.

The simulated results for the various scenarios do not seem to provide any straightforward explanation of the determinants of structural change and growth in services in Germany. However, it allows us to seriously question the "Baumol's disease" explanation, at least for the period considered. A sounder explanation of the structural changes leading to the growth in services might be found at the micro–level of analysis, particularly in the nature of technological shocks. In this respect, the model considers symmetrical shocks whereas in reality these shocks are asymmetric and *de facto* lead to sectoral differences in growth rates and output concentration. However, this asymmetry can hardly be introduced directly into the model, but evidence upholding this idea might be found in micro-level empirical contributions (Cainelli, Evangelista, and Savona, 2006).

Moreover, as found in Savona and Lorentz (2005) in the case of Germany, the growth of services seems to have been complementary rather then detrimental to the growth in manufacturing sectors. Tertiarisation processes in Germany have been driven by the combination of highly productive manufacturing sectors and asymmetric technological shocks. These shocks have favoured the expansion of services following an increase in the inter–sectoral division of labour (i.e. the extension of outsourced activities by the manufacturing sectors) and an increase in intermediate demand for service activities. A more in–depth exploration of such a scenario would require a more "history-friendly" approach. Unfortunately, the data used to set some of the initial parameters in the present work do not allow the use of this methodological tool. This might be a subject for future research developments.

4 Final remarks

The paper aimed to add to the on-going debate on the determinants of structural changes to the economy, particularly those leading to the growth of services. In the present work we have built upon the empirical evidence found in Savona and Lorentz (2005) and summarised in Section 1. Our conjecture is that the determinants of structural change and particularly the growth of services in the advanced countries over the last few decades, imply the co–presence of (and most likely a virtuous circle between) a sustained growth in patterns of final demand, especially private and public domestic consumption, and radical changes in the sectoral division of labour, following technological changes and changes in the production organisation of most branches of the economy.

A growth model with evolutionary micro-founded structural change was developed in Section 2. The model was simulated on the basis of three different scenarios, accounting for both intermediate demand and technological determinants of structural change. The scenarios were identified both along the main lines around which the debate over tertiarisation has revolved over time, and on the empirical evidence found in previous work (Savona and Lorentz, 2005) and supported by other empirical contributions (van Ark, Inklaar, and McGuckin, 2002; Peneder, Kaniovsky, and Dachs, 2003; Cainelli, Evangelista, and Savona, 2006; Kox and Rubalcaba, 2007).

The simulation results based on the actual German data allow us to conclude that the structural changes that occurred in the case of Germany cannot be due to inter–sectoral differences in productivity growth. In other words, and in line with the empirical evidence, the "Baumol's disease" case is not able to account for the actual (and most recent) patterns of tertiarisation that have occurred in Germany. Rather, it is the intertwined effect of changes in the intermediate demand and technological shocks that has been operating.

However, more a refined account of the nature and effects of technological shocks at the micro–level should be considered. The model is based on the hypothesis of symmetrical technological shocks. We plan to abandon this simplified hypothesis in future work in order to account for asymmetrical technological shocks across firms and sectors. In line with the methodological approach adopted in this work, we intend to do this by relying on empirical evidence based on micro–level data. This will be a part of our future research agenda.

Overall, this work aimed at healing the fracture between Keynesian and neo-Schumpeterian 'lines of thought' (Verspagen, 2002) in the belief that more effort should be devoted to integrating - especially in the domain of services - these two main theoretical streams. As part of our future research agenda we intend to explore in more depth growth and changes in the composition of final demand, which, along with the dramatic changes in cross–sectoral intermediate linkages accounted for in the present work, might be the ultimate shapers of changes in the structural composition of advanced economies.

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Appendix

Table 2: Sectors Included in the analysis

ISIC Rev.3	**Acronym**	**Industry**
1-14	AGRI	Agriculture, hunting, forestry, fishing, mining, and quarrying
15-16	FOOD	Food products, beverage and tabacco
17-19	TEXTILE	Textiles, textile products, leather and footwear
20-22	WOOD	Wood, wood products, cork, pulp, paper, paper products, printing and publishing
23-26	CHEM	Chemical, rubber, plastic, fuel products, and other non-metallic mineral products
27-35	MACHINERY	Basic and fabricated metal prod., machinery and equipments
36-37	MANEC	Manufacturing n.e.c.
40-45	ELEC	Electricity, Gas, Water and Construction
50-55	TRADE	Wholesale and retail trade; Hotels and restaurants
60-64	TRACOM	Transports, storage and communications
65-67	FINANCE	Financial Intermediation
70-74	KIBS	Real estate; Renting of machinery and equipment; computer and related; R&D; business services**
75-99	SOCIAL	Community; social; personal and other government services

**Business services (74) includes: Legal and Accounting; Engineering; Technical Consultancy; Marketing; Training; Cleaning; Security

Table 3: Initial I–O coefficients (Germany 1978)

	AGRI	FOOD	TEXTILE	WOOD	CHEM	MACHINERY	MANEC	ELEC	TRADE	TRACOM	FINANCE	KIBS	SOCIAL
AGRI	0.161	0.302	0.030	0.037	0.096	0.016	0.001	0.059	0.013	0.000	0.001	0.009	0.003
FOOD	0.088	0.218	0.000	0.000	0.005	0.000	0.000	0.000	0.059	0.006	0.001	0.009	0.011
TEXTILE	0.001	0.001	0.329	0.016	0.003	0.002	0.005	0.001	0.002	0.002	0.001	0.002	0.003
WOOD	0.009	0.017	0.007	0.246	0.016	0.009	0.026	0.031	0.027	0.011	0.017	0.008	0.047
CHEM	0.077	0.030	0.072	0.080	0.303	0.046	0.066	0.140	0.022	0.057	0.004	0.018	0.016
MACHINERY	0.059	0.009	0.013	0.027	0.025	0.392	0.240	0.066	0.013	0.047	0.010	0.014	0.016
MANEC	0.003	0.009	0.006	0.016	0.008	0.012	0.038	0.015	0.002	0.002	0.002	0.001	0.001
ELEC	0.049	0.011	0.015	0.021	0.036	0.017	0.014	0.047	0.022	0.022	0.010	0.054	0.003
TRADE	0.027	0.035	0.052	0.050	0.039	0.048	0.053	0.032	0.051	0.043	0.014	0.013	0.009
TRACOM	0.023	0.027	0.018	0.035	0.031	0.019	0.022	0.025	0.034	0.100	0.029	0.008	0.009
FINANCE	0.027	0.011	0.020	0.021	0.015	0.019	0.023	0.028	0.038	0.047	0.023	0.046	0.010
KIBS	0.017	0.024	0.039	0.035	0.047	0.037	0.042	0.037	0.104	0.025	0.142	0.069	0.017
SOCIAL	0.008	0.002	0.002	0.002	0.002	0.002	0.003	0.001	0.006	0.002	0.008	0.013	0.009

Source: OECD Input Output Tables, own calculation

Table 4: Initial values for selected coefficients (Germany 1978)

	Exports	Consumption shares	Import shares	K–V coefficients	
	$X_{j,t}$*	$c_{j,t}$*	$m_{j,t}$*	λ_k**	β_k**
AGRI	9768.69	0.008	0.395	0.872	-0.002
FOOD	14510.06	0.047	0.114	0.862	-0.001
TEXTILE	16484.99	0.019	0.353	0.475	0.034
WOOD	10152.96	0.008	0.131	0.715	-0.002
CHEM	65014.43	0.024	0.217	0.851	-0.001
MACHINERY	204944.78	0.030	0.172	0.582	-0.001
MANEC	12873.43	0.005	0.228	0.612	0.005
ELEC	3117.50	0.012	0.005	0.469	-0.021
TRADE	13869.20	0.062	0.018	0.717	-0.002
TRACOM	23830.67	0.014	0.080	0.902	0.001
FINANCE	366.39	0.008	0.004	0.928	-0.03
KIBS	7777.17	0.054	0.030	0.217	0.004
SOCIAL	3263.04	0.098	0.013	0.812	-0.011

Source: *OECD Input Output Tables, own calculation
**OECD STAN, own calculation