Business and Financial Services: New Engine of Economic Growth?

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Abstract

Does the continuous shift of resources from the traditional sectors to the business and financial services sector imply inevitable stagnation in the aggregate productivity growth in the developed economies? Economic inquiry into this issue has generated contradictory conclusions. This paper evaluates the traditional stagnationist and the modern optimist arguments and employs an applied general equilibrium multi-sectoral growth model to simulate the impact of unbalanced sectoral productivity growth on the overall productivity growth path. A particular focus is on the relationship between a sector's industrial linkages and its impact on overall growth. The simulation results suggest that the actual aggregate productivity growth path in the long-run deviates from either case.

Key words: unbalanced total factor productivity growth, multi-sector growth model

JEL classification: O41, O14, C68

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1. Introduction

Recent decades have witnessed a substantial growth of the services sectors, particularly Business and Financial Services (BFS) sector, relative to the rest of the economy across the developed countries. As a result, the BFS sector has steadily increased its share in total output and employment at the expense of the traditional sectors such as manufacturing. Table 1 presents evidence of the changing industrial structure and the rise to eminence of the BFS sector in the UK over the period from 1978Q2 to 2004Q2. Due to the controversy in measuring output in the BFS and other services sectors, we use employment data to illustrate cross-sector growth comparisons.

Table 1 Changing UK industrial structure and the eminence of the BFS sector

Sector	Average quarterly rate of growth in sectoral employment, 1978Q2-2004Q2 (%)	Sectoral share of total full-time employment in 1978Q2 (%)	Sectoral share of total full-time employment in 2004Q2 (%)
Agriculture	-0.67	1.9	0.8
Energy & water	-1.20	2.8	0.7
Manufacturing	-0.69	28.6	12.9
Construction	-0.07	5.7	4.8
Distribution	0.29	19.4	24.3
Transportation	-0.02	6.6	5.9
Banking & finance	0.67	10.5	19.4
Public services	0.29	20.8	25.9
Other services	0.43	3.7	5.3
Total services	0.08	61.0	80.8

Source: ONS on-line data archive. Employment refers to employees in employment which excludes self and part-time employment.

As is clear from the table, over the past two decades, all the traditional sectors have been steadily losing employment whereas all the services sectors have been gaining employment. In relative terms, the biggest losers are Energy and Water, Manufacturing and Agriculture whilst the biggest gainers are BFS, Other Services and Public Services. By the second half of

2004, all the services sectors accounted for 81% of total full-time employment in the UK and three sectors (Public Services, Distribution and BFS) alone shared around 70% of the total. It is also worth noting that the BFS sector has been enjoying the fastest quarterly growth rate of employment among all the sectors for over two decades.

In contrast to the pattern of employment growth in different sectors, the traditional sectors have consistently outperformed the services sectors in terms of productivity growth, as is clearly shown in Table 2.

Table 2 Sectoral productivity growth in the UK

Sector	Rate of growth in sectoral labour productivity per annum, 1973 – 1996 (%)
Agriculture	3.66
Energy & water	2.60
Manufacturing	4.96
Construction	3.14
Distribution	1.52
Transportation	3.88
Banking & finance	2.07
Other personal services	1.57

Source: N.Oulton (2001).

This contrasting picture of sectoral performance in employment (and output) growth on the one hand and productivity growth on the other hand is certainly not a new phenomenon and has led to the long-standing concern over the possibility of stagnation in the overall productivity growth in a developed economy. The concern was originally presented in a seminal paper by Baumol (1967) which explained why productivity growth may be intrinsically slower in the services sectors than in the manufacturing sectors and the implications of unbalanced sectoral productivity growth for relative costs, the structure of employment and the overall productivity growth rate. The central theme of Baumol's analysis is that sectors with stagnant productivity growth (viz. services) will experience a rapid rise in their relative cost and share of total resources (employment) and ultimately the overall productivity growth will converge to that of the stagnant sectors. Such a pessimistic view was expressed again, in the form of asymptotic stagnancy hypothesis, in a number of later studies by Baumol (1985) and Baumol et al. (1989). However, this view was recently challenged by Nicholas Oulton (2001) who evaluated the traditional stagnationist argument and presented his own optimistic assessment of the issue. A central argument by Oulton is that Baumol's theoretical framework omits sectoral industrial (or intermediate) linkage with the rest of the economy, but such a linkage is shown to have a significant impact on the overall productivity growth path. Since BFS has strong industrial linkages with the other industries, so goes the optimist argument, any positive growth in this sector, no matter how much slower it is than that of the manufacturing sectors, will contribute to a higher overall growth rate in the aggregate economy.

The Baumol-Oulton controversy is cast in the conventional growth accounting – partial equilibrium framework without explicitly considering the interactions between factor price, product price, resource allocation and market demand. A more general and rigorous framework for examining multi-sectoral growth mechanisms is the Uzawa two-sector growth model and its extensions that attracted much interest in the 1960s and 1970s (see, for example, Uzawa, 1961, 1963; Meade, 1961; Kurz (1963); Burmeister and Dobell, 1970; Stiglitz and Uzawa, 1970). Although the Uzawa two-sector model does not consider unbalanced growth explicitly, the discussion on the inclusion of the demand side for model closure and the sufficient and necessary condition for achieving equilibrium and dynamic stability is relevant in the current context. A largely informal treatment of the balanced and unbalanced growth mechanisms has also appeared extensively in the literature on economic development. The emphasis of that literature was on the explanation of the nature of the positive feedback mechanisms that can lead to self-reinforcing growth or stagnation. There seems to be a current revival of interest in the multi-sectoral unbalanced growth models (e.g., Baumol, 1989; Rauch, 1997; Oulton, 2001; Jensen and Larsen, 2004). However, the literature seems to have largely ignored the implications of technical progress for the resource constraint faced by the economy. Continuous technical progress implies that the effective supply of labour in efficiency units is infinite in the long-run. Unbalanced sectoral technical progress suggests that not only the total amount but also the sectoral composition of effective labour supply is constantly changing. Due to the technical complexity regarding general economic equilibrium in the context of unbalanced growth, no formal proof has been presented for the existence of a globally stable overall growth path for the aggregate economy. Although the literature has identified a number of (mostly) sufficient conditions for stability, the conditions are judged to be either peculiar or highly restrictive (see, e.g. Hahn, 1965). This study re-examines the Baumol-Oulton controversy in the context of an extended Uzawa two-sector growth model with the incorporation of the sectoral intermediate linkages and unbalanced sectoral technical progress. Moreover, given the lack of general theoretical proof of the stability of the overall growth path, this study employs an applied general equilibrium multi-sectoral growth (MSG) model to simulate the impact of sectoral productivity growth on the aggregate productivity growth path. A major advantage of this framework is the incorporation of factor price determination and market demand that are absent in the conventional theoretical framework. Since the analyses of Baumol and Oulton have both adopted the conventional neo-classical exogenous growth mechanism, it is also adopted in this study. We leave the incorporation of endogenous growth mechanisms to future research agenda.

2. The Baumol-Oulton controversy

The general theoretical framework of the stagnationist view is set out in Baumol (1967). The main arguments of the paper can be summarised as follows. 1) Services have inherently slower productivity growth rate than manufacturing. Given the assumption of equal wage rate across economic sectors and sufficient price inelasticity or income elasticity of demand for services, more and more workers will be absorbed by services and the relative unit cost of production in services will rise without limit. Asymptotically, services' share of employment approaches one. 2) The total factor productivity (TFP) growth rate in the aggregate economy will asymptotically approach zero in the long run. 3) The relative price of services will rise, leading to the share of consumer spending in services out of total consumer spending approaching asymptotically unity. However, Oulton (2001) argues that Baumol's results are only applicable if the two sectors are both final goods producers. By introducing an intermediate as well as a final good sector, the story changes completely. Oulton's main conclusions are as follows. 1) If the slow-growing sector provides intermediate services, any productivity growth in that sector makes additional contribution to the overall TFP growth rate. Thus, overall TFP growth rate can never be lower than the slowest TFP growth rate in the stagnant sector so long as it produces intermediate products. 2) BFS is a significant provider of intermediate services. As long as productivity growth in BFS is positive, overall TFP growth will generally be significantly above the slowest growth rate.

For the purpose of clarifying later discussion, a very brief technical representation of the Oulton results is presented here. Let y_i, x_i, m_i, w_i, p_i and p_i^m denote the gross output, a single input (either labour or a composite input), intermediate input, factor price, product price and the price of the intermediate input in a sector i, and let the total output production function to be $y_i = f_i(x_i, m_i, t)$ where t is time. Assuming constant returns to scale and perfect competition, then the TFP growth in sectoral output in the ith industry can be obtained as the Solow residue (note that a hat ^ above a variable denotes the instantaneous rate of growth in that variable):

$$\widehat{q}_i = \widehat{y}_i - (\frac{w_i x_i}{p_i y_i})\widehat{x}_i - (\frac{p_i^m m_i}{p_i y_i})\widehat{m}_i \tag{1}$$

Through some algebraic manipulation, it is possible to obtain an important relationship between the productivity growth rate in value added and the productivity growth rate in gross output in that sector:

$$\widehat{q}_i^v = (\frac{p_i y_i}{w_i x_i})\widehat{q}_i \tag{2}$$

Thus, TFP growth in value added can never be less and usually larger than TFP growth in gross output. On the basis of equation (2) and other conditions, Oulton is able to arrive at the relationship between the productivity growth rate in aggregate value added (which is taken to measure the overall productivity growth rate) and the sectoral productivity growth rates in outputs in individual sectors:

$$\widehat{q} = \sum_{i=1}^{n} (\frac{p_i y_i}{p^v v})\widehat{q}_i \ , \tag{3}$$

where v is aggregate value added (or GDP) and p^v is its price. Oulton terms this relationship "Domar aggregation", which shows that the aggregate TFP growth is a weighted sum of the sectoral TFP growth rates in outputs with the weights summing to more than one. Oulton seems to have derived his optimistic view on the basis of equation (3). Moreover, his optimism is further strengthened through the illustration of a simple example of two sectors, one producing intermediate inputs only (BFS) and the other producing a final output only (Cars). The production functions for the two sectors are specified as follows:

$$y_1 = x_1 \exp(\hat{q}_1 t) \tag{4}$$

$$y_2 = f(y_1, x_2) \exp(\hat{q}_2 t) \tag{5}$$

In this special case, Oulton illustrates that under simple conditions[1], asymptotically the aggregate TFP growth rate is simply the sum of the individual sectoral TFP growth rates, i.e. $\widehat{q} = \widehat{q}_1 + \widehat{q}_2$.

3. An examination of the Baumol-Oulton controversy

The analyses by Baumol and Oulton are cast in a disaggregated national income accounting framework and thus have a number of limitations. To start with, the treatments of the inter-industry linkage by Baumol and Oulton represent the opposite extreme cases. In Baumol's case, there is no intermediate linkage between the two sectors and each sector competes for resources with the other sector to produce the goods and services for final consumption. Whereas in Oulton's case, the production process by one sector (BFS) is treated as completely complementary to that of the other (manufacturing). Since one sector is assumed to produce intermediate inputs only, the whole sector's output can be regarded as another input for the production process of the final good sector. According to the national income accounting principle, total (net) output in the economy (or GDP) is simply the gross output of the final good sector which is produced with two inputs: one primary and the other the output of the BFS sector. Therefore, Oulton's two-sector model as represented by equations (4) and (5) can thus be reduced to the conventional Neo-classical one-sector growth model with the primary input x only:

$$v = y_2 = f(x_1 \exp(\hat{q}_1 t), x_2) \exp(\hat{q}_2 t) \tag{6}$$

By assuming a Cobb-Douglas form for the production function, it is straightforward to obtain the aggregate GDP growth rate as: $\hat{v} = r_1 \widehat{q}_1 + \widehat{q}_2$ where r_1 is the share of industry one's output in the total cost of industry two. Since output growth is assumed here to be derived entirely from technical progress and r_1 is asymptotically approaching 1, we can again obtain the Oulton result that $\widehat{q} = \widehat{q}_1 + \widehat{q}_2$. It is worth noting that here the demand for industry

[1] Such as Hick neutral technical progress and the elasticity of substitution between labour and the intermediate input in the car industry being greater than one.

one's output (i.e. BFS) is implicitly assumed to be completely price inelastic and there is no alternative substitute for y_1 apart from x_2.

However, in the real world, the inter-industry linkage is far more complex than either case with almost every sector exhibiting both substituting and complementary intermediate relationships with the other sectors[2]. Moreover, such linkages typically go beyond the national border and different sectors face different extent of import substitution in intermediate inputs. Therefore, even from a mechanistic perspective, the relationship between the economy's overall TFP growth rate and individual sectors' TFP growth rates may differ from the results obtained by either Baumol's weighted average or Oulton's simple Domar aggregation methods. In fact, Oulton's equation (3) does not necessarily produce an aggregate TFP growth rate that is significantly above the slowest sectoral TFP growth rate, as the share of (nominal) output (i.e. $p_i y_i / \sum p_i y_i$) by the fast-growing sectors may be significantly lower than that by the slow-growing sectors so that the weight attached to the sectoral TFP growth rate (i.e. $p_i y_i / p^v v$) in the fast-growing sector may be insignificant. Therefore, whether or not Domar aggregation will produce superior aggregate TFP growth rate depends crucially on the evolution of the sectoral shares of output and the wedge between the volume and price of gross outputs on the one hand and the volume and price of value added on the other. However, Oulton's framework makes no such considerations – a point we turn to next.

Another limitation of Baumol and Oulton's models is that they focus exclusively on the supply side of the economy only. As such they omit some important general equilibrium mechanisms such as price determination and market demand. Yet such mechanisms are essential for understanding resource allocation and growth mechanisms. Conceptually, in keeping with the spirit of the neoclassical growth models, the initial sectoral factor intensity and changing factor market conditions will impact upon the outcome of the Domar aggregation procedure and thus the overall TFP growth path. Moreover, from a Keynesian perspective, the structure of aggregate demand also matters. Even in the highly simplified models of Baaumol and Oulton, stringent assumptions have to be made regarding the income

[2] One exception is Public Administration which is typically assumed to have no intermediate linkage in the input-output system.

and price elasticities of demand for goods and services. As Rowthorn (1992) points out, in decomposing the increase in the share of services in total employment in the US from 1973-1988, less than two-fifths of the increase was due to the productivity lag in services, while more than three-fifths was due to the faster growth in the output of services as compared to goods. This implies that demand factors rather than unbalanced productivity growth were the major force behind the apparent shift to a service economy in the US over that time period. However, a rigorous incorporation of the demand side into a long-run model of economic growth remains an intellectual challenge. Therefore, the focus of this paper is still on the supply-side.

It should be particularly pointed out that both Baumol and Oulton have failed to examine the impact of unbalanced sectoral TFP growth on the effective supply of factors and their composition, and hence on relative factor price and product price. Both Baumol and Oulton have followed the conventional literature on balanced growth path in assuming that the wage rate is the same across all sectors and changes at the same rate (which is usually taken to be equal to the exogenous rate of technical progress). However, a change in the productivity level of a factor of production changes the effective supply of that factor. Moreover, unbalanced TFP growth not only changes the total amount but also the composition of the economy's effective supply of factors. In the presence of exogenous factor productivity growth, the constant returns to scale property of the conventional production functions will no longer hold in relation to the factors measured in physical units. Therefore, when sectors have unbalanced TFP growth rates, the conventional result of equal (real) factor price growth rate across sectors does not necessarily hold any more. In a general equilibrium context, unbalanced sectoral TFP growth has profound impacts on sectoral factor intensity, relative factor prices, relative product prices (or sectoral terms of trade), and the structure of production and demand in the economy. As the original Uzawa two-sector growth model illustrates, the evolution of the relative factor price (i.e., the wage/capital price ratio) governs whether or not unique factor market equilibrium and a stable steady-state growth path exist. Without examining the interactions between factor prices and product prices in a general equilibrium setting, any discussion of the equilibrium growth path in the context of unbalanced growth is partial and highly restrictive.

The crucial difference between the Baumol results and that of Oulton is clearly due to the absence or presence of intermediate linkages in the modelled economy. The role of intermediate production has received central attention in the literature on industrial linkages and economic growth/development, which is technically captured in Hirschman's Backward Multipliers (BM) and Forward Multipliers (FM). Moreover, it is commonly assumed, although never formally proven, that growth in sectors with strong industrial linkages will act as an impetus (or the engine) to the overall growth rate. This sentiment seems to be shared by Oulton and others (hence the emergence of the term "soft engine of economic growth"). In the following section, we introduce an extended Uzawa two-sector-two-factor growth model. Our extension lies primarily with the introduction of intermediate linkages into the production processes as well as unbalanced technical progress across sectors. Our intension is to shed light on the complex nature regarding the dynamic properties of multi-sector growth (MSG) models on the one hand and to suggest the rationale for introducing simulation techniques on the other hand.

4. Unbalanced growth in a two-sector-two-factor growth model with intermediate production and unbalanced technical progress

We assume that the economy consists of two sectors producing two goods with two homogeneous inputs: labour and capital. We assume a nested CES production structure for each of the two sectors: sectoral gross output is a composite of value added and intermediate production; value added in turn is produced by labour and capital; and intermediate input consists of own good and the other good.

$$y_i = [\alpha_i v_i^{-\rho} + (1-\alpha_i) m_i^{-\rho}]^{-1/\rho} \qquad \text{Gross output} \qquad (7)$$

$$v_i = [\beta_i (\theta_i L_i)^{-\rho} + (1-\beta_i)(\theta_i K_i)^{-\rho}]^{-1/\rho} \qquad \text{Value added} \qquad (8)$$

$$m_i = [\gamma_i x_{ii}^{-\rho} + (1-\gamma_i) x_{ji}^{-\rho}]^{-1/\rho}, \;\; j \neq i \qquad \text{Composite intermediate input} \qquad (9)$$

$$x_{ij} = a_{ij} y_j \qquad \text{Sectoral intermediate input} \qquad (10)$$

where i, j (=1, 2): index for sectors; v: value added; m: composite intermediate input which consists of own good and the other good; θ is a labour and capital augmenting factor; a_{ij} is the fixed intermediate input-output coefficients; ρ is related to the elasticity of substitution between two inputs ($\sigma = \frac{1}{1+\rho}$). For simplicity reasons, we assume that the elasticity of substitution is the same across sectors and the levels of the production hierachy. We also assume that θ evloves from an initial level of technology in the following way: $\theta_i = \theta_{i,0} \exp(r_i t)$ **.** Therefore, we are assuming Hicks-neutral technical progress at the rate of r_i in sector i ($r_1 < r_2$). On the basis of equations (7) to (10), we can derive the corrsponding growth rates:

$$\hat{y}_i = s_i^v \hat{v}_i + (1 - s_i^v)\hat{m}_i \tag{11}$$

$$\hat{v}_i = r_i + s_i^L \hat{L}_i + (1 - s_i^L)\hat{K}_i \tag{12}$$

$$\hat{m}_i = \hat{y}_i \tag{13}$$

where the s's are the share parameters (e.g., $s_i^v = \frac{\alpha_i v_i^{-\rho}}{\alpha_i v_i^{-\rho} + (1-\alpha_i) m_i^{-\rho}}$ is the share of value added in gross output, s_i^L is the share of labour income in value added). It is straightforward to obtain the sectoral TFP growth rate in value added as:

$$\hat{q}_i^v = r_i \tag{14}$$

To derive the TFP growth rate in output, we substitute equation (8) into (7) and re-express the growth rate in output in terms of the growth rates of three primary inputs:

$$\hat{y}_i = s_i^L (r_i + \hat{L}_i) + s_i^K (r_i + \hat{K}_i) + (1 - s_i^L - s_i^K)\hat{m}_i \tag{15}$$

where $s_i^L = \frac{\alpha_i \beta_i (\theta_i L_i)^{-\rho}}{\alpha_i \beta_i (\theta_i L_i)^{-\rho} + \alpha_i (1-\beta_i)(\theta_i K_i)^{-\rho} + (1-\alpha_i) m_i^{-\rho}}$ is the share of labour in gross output and $s_i^K = \frac{\alpha_i (1-\beta_i)(\theta_i K_i)^{-\rho}}{\alpha_i \beta_i (\theta_i L_i)^{-\rho} + \alpha_i (1-\beta_i)(\theta_i K_i)^{-\rho} + (1-\alpha_i) m_i^{-\rho}}$ is the share of capital. Thus, the sectoral TFP growth rate in output is obtained as:

$$\hat{q}_i = (s_i^L + s_i^K) r_i = (s_i^L + s_i^K)\hat{q}_i^v \tag{16}$$

Since $s_i^L + s_i^K < 1$, the sectoral TFP growth rate in output is unambiguously lower than the sectoral TFP growth rate in value added. Moreover, the higher the share of intermediate input in a sector, the larger the gap between the two growth rates. This is a similar result to that in Oulton's equation (2). However, there is a subtle difference between Oulton's equation and the present one in terms of the causality of the relationship between the two growth rates. In equation (2), the starting point is an exogenous growth rate in sectoral output. Thus, a higher intermediate linkage in one sector leads to a higher growth rate in sectoral value added, which in turn contributs to a higher overall growth rate (also expressed in terms of value added). However, a problem with the assumption of exogenous productivity growth rates in output across sectors, which is adopted by both Baumol and Oulton, is that the analyst is actually imposing exogenous growth rates for both sectoral outputs and labour inputs. In contrast, in equation (16), the starting point is an exogenous sectoral technical progress rate and the productivity growth rate in output is derived from the production system. If the intermediate linkage is stronger, this techincal progress will translate into a slower sectoral growth rate in output. But so far, we have said nothing about how the overall TFP growth rate (in value added) relates to all of these.

In ordr to do so, the literature (as do Baumol and Oulton) assumes that the aggregate TFP growth rate (in value added or output) is simply a weighted average of the sectoral TFP growth rates, with the weights being calculated as the exogenous sectoral shares in nominal value added or nominal output. A problem with this approach immediately arises: in a growth context, such shares are constantly changing. Even if the shares have to be fixed, one still has to decide which year's shares should be used. Therefore, a simple aggregation scheme such as the one presented in equation (3) is at best a rough approximation. This reservation is indeed confirmed by our simulation results later. A satisfactory approach must take into account the changing patterns of prices as well as quantities. Unfortunately, such an approach necessitates the incorporation of the factor market and the goods market into the modelling system. A comprehensive and rigorous treatment is beyond the remit of this paper. In the next few sections, we explore some relevant aspects.

We adopt the standard assumption of zero profit at every level of the production hierachy so that we have:

$$p_i^y y_i = p_i^v v_i + p_i^m m_i \tag{17}$$

$$p_i^v v_i = W_i L_i + R_i K_i \tag{18}$$

$$p_i^m m_i = p_i^y x_{ii} + p_j^y x_{ji} \tag{19}$$

where W is the nominal wage and R is the capital rental rate. Aggregate output and value added are calculated as follows[3]:

$$p^y y = \sum p_i^y y_i \tag{20}$$

$$p^v v = \sum p_i^v v_i \tag{21}$$

To examine the potential shift of labour resources between sectors, we derive the optimal sectoral demand for labour inputs as follows:

$$L_i = \left(\frac{p_i^v \beta_i}{W_i}\right)^{\sigma} v_i \theta_i^{\sigma-1} \tag{22}$$

Let S = L_1/L_2 denote the ratio of labour inputs in the two sectors, then the rate of change in S is:

$$\hat{S} = \sigma(\hat{w}_2 - \hat{w}_1) + \hat{v}_1 - \hat{v}_2 + (\sigma - 1)(r_1 - r_2) \tag{23}$$

Where $w_i = W_i / p_i^v$ is the real wage rate. In the literature, it is usually assumed that $\hat{w}_2 = \hat{w}_1$. However, given unbalanced sectoral technical progress, we make no such presumption. In a perfectly competitive labour market, the real factor prices equal their marginal products. Thus,

$$w_i = \frac{\partial v_i}{\partial L_i} \tag{24}$$

$$r_i^K = \frac{\partial v_i}{\partial K_i} \tag{25}$$

The rate of change in the sectoral real wage rate is:

$$\hat{w}_i = r_i + (1+\rho)(1 - s_i^L)(\hat{K}_i - \hat{L}_i) \tag{26}$$

We further define the sectoral unit labour cost as: $UCL_i \equiv \frac{W_i L_i}{p_i^i v_i}$. Then it is possible to derive the rate of change in the relative unit labour cost in the two sectors as:

$$\hat{r}_{UCL} = \frac{\sigma - 1}{\sigma}[(1 - s_1^L)(\hat{L}_1 - \hat{K}_1) + (1 - s_2^L)(\hat{K}_2 - \hat{L}_2)] \tag{27}$$

Therefore, one sufficient condition for labour to shift to the slower-growing sector (sector one) is: $\sigma > 1$ and $(1 - s_1^L)(\hat{L}_1 - \hat{K}_1) > (1 - s_2^L)(\hat{L}_2 - \hat{K}_2)$ (i.e., sector one is becoming

[3] In the original Uzawa model, the definition for sectoral outputs and aggregate output is inconsistent: the former is defined in real (or volume) terms but the latter is in nominal (or value) terms. Thus aggregate output is not homogeneous of degree zero in all the prices.

relatively more labour intensive). However, this condition is not necessary for labour to shift to sector one.

The central contribution of the original Uzawa model is to enable the derivation of the sufficient conditions for achieving the factor market equilibrium and the steady-state growth path. Such a task is far more complicated in the present context. As is well known in the original Uzawa models, different assumptions about the savings behaviour in the economy generate different sufficient conditions for the attainment of unique market equilibrium and dynamic steady state. Our extensions will necessarily complicate the dynamic properties of the original Uzawa models even further. Therefore, we do not attempt to search for the formal sufficient or necessary conditions for achieving equilibrium or steady-state (a recent theoretical attempt is made in Jensen and Larsen, 2004). As the original Uzawa two-sector model illustrates, such an endeavour is already highly complex and controversial[4]. Moreover, the Uzawa model does not depict the aggregate growth path or explore how it is related to the growth rate in labour and capital, which is the primary concern in this study. In the next section, we introduce a fully-fledged applied multi-sectoral growth model to simulate the growth paths of the economy in the context of unbalanced sectoral technical progress.

5. A general equilibrium MSG model for a small open economy

The simulation model that we adopt is a general equilibrium MSG model for a UK region – Scotland. The model has been used extensively for policy analysis (for example, see Harrigan, et. al. 1991; McGregor, et. al.; Ferguson, et. al., 2005). The following section presents a brief summary of the main features of the model used for the current study.

- Economic transactors: Households, firms, government, residents in the rest of the UK (RUK) and the rest of the world (ROW).
- Production structure and factor market: There are three sectors, manufacturing, non-manufacturing traded (NMT) and sheltered. The NMT sector is dominated by BFS. The sheltered sector is distinguished from the other sectors through the adoption of much lower import and export propensities than the other sectors. The hierarchical structure of production is very similar to the one introduced in the above section. We impose cost

[4] According to Frank Hahn (1965), the assumptions adopted for deriving the necessary or sufficient conditions achieving uniqueness and dynamic stability are all terrible assumptions.

minimisation in production with multi-level CES production functions at almost every level of the hierarchy. Intermediate imports are generally determined via an Armington link (Armington, 1969). Exogenous Hick-neutral technical progress is introduced into the sectoral value added production functions. All markets are assumed to be competitive. Moreover, given the small open nature of the regional economy, all factors are assumed to be imperfectly mobile in the short-run through the imposition of sluggish adjustment factors in the regional migration function and the investment function, but perfectly mobile in the long run.

- Final demand: there are four major components of final demand: consumption, investment, government expenditure and exports. Of these, real government expenditure is exogenous. Consumption is a linear homogeneous function of real disposable income. Exports (and imports of final goods) are also generally determined via the Armington link. Investment is determined in such a way that the actual capital stock is ultimately adjusted to the desired capital stock, which is compatible with a simple theory of optimal investment behaviour given the assumption of quadratic adjustment costs.

Therefore, apart from the empirical richness and the introduction of unbalanced sectoral technical progress, the simulation model is very similar to the theoretical counterpart of the conventional two-sector growth model. Through simulations, we aim to shed light on the following central questions:

- Does unbalanced sectoral productivity growth lead eventually to the overall growth rate converging to the growth rate of the slowest-growing sector?
- Which sector provides the strongest spur to the overall growth rate?
- Are the above results dependent on the sector's industrial linkage?

6. Empirical results and discussion

6.1. Sectoral industrial linkages

Since a key issue to be investigated is the relationship between a sector's industrial linkage and the impact of its TFP growth on the overall TFP growth path, we present below empirical evidence for measuring the sectoral industrial linkages for the UK and Scotland in Table 3 and 4.

Table 3 UK industrial linkage, 2003

	Share of intermediate use in gross output (%)	Backward multipliers	Forward multipliers
Agriculture	49.68	2.21	1.27
Mining and quarrying	63.49	1.59	1.65
Manufacturing	38.41	2.45	5.00
Electricity, gas and water supply	64.55	2.34	1.70
Construction	43.00	2.39	1.86
Wholesale and retail trade	17.42	2.01	1.23
Transport and communication	67.85	2.11	2.20
Financial intermediation	62.00	1.77	4.03
Public administration	5.21	2.13	1.05
Education, health and social work	18.81	1.83	1.30
Other services	35.67	1.93	1.45

Source: derived from the UK input-output table for 2003 by the ONS.

Table 4 Scottish industrial linkage, 1989

	Share of intermediate use in gross output (%)	Backward multipliers	Forward multipliers
Manufacturing	21	1.44	1.28
Non-manufacturing traded	35	1.32	1.47
Sheltered	17	1.19	1.19

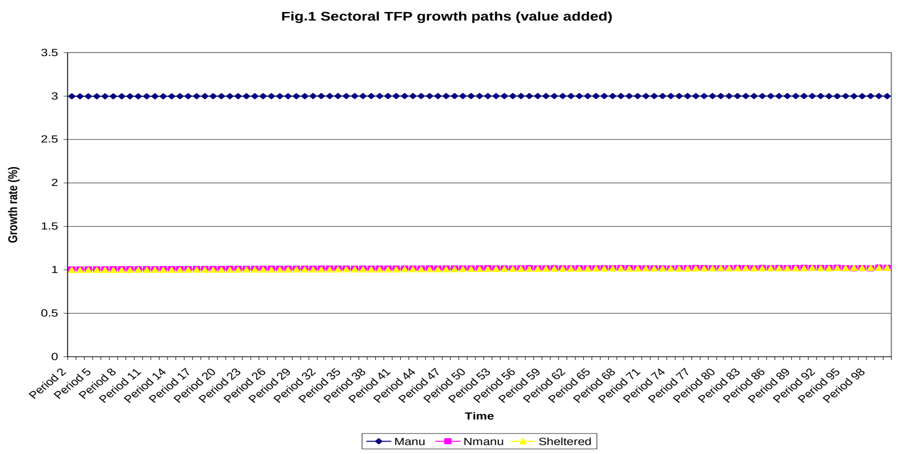
Source: derived from the Scottish input-output table for 1989 by the Scottish Office.

It is clear from both Table 3 and 4 that a significant proportion of the BFS output goes into intermediate use (the proportion seems to have risen over the past decade). In Scotland, the product of the non-manufacturing sector, of which BFS are a dominant part, has the highest share of intermediate use. Moreover, the BFS sector also has the highest forward linkage in the Scottish economy and the second highest forward linkage in the UK. The backward linkage between the BFS and the rest of the economy is also substantial. Similarly, manufacturing has very important backward and forward linkages with the rest of the economy. In both the UK and Scotland, the sheltered sector has the weakest forward or backward linkages.

Having established the sectoral industrial linkages in our modelled economy, we now turn to simulate the impact on the overall productivity growth path by introducing unbalanced Hicks-neutral technical progress to each of the three sectors. If the stagnationist view holds, we should expect overall TFP growth rate converging to the slowest sectoral TFP growth rate. On the contrary, if the optimist view holds, we should expect to see the overall TFP growth rate to be significantly higher than any individual sector's TFP growth rate. Moreover, if we believe that intermediate linkages are important in determining a sector's impact on the overall TFP growth, improvement in productivity growth in BFS should exert the strongest impact, whereas productivity improvement in the sheltered sector has the weakest impact, on the overall productivity growth. We now turn to examine the simulation exercises.

6.2. Simulation results

In the first simulation, we impose 3% Hicks-neutral technical progress in the manufacturing sector and 1% technical progress in the remaining two sectors. This set-up reflects the common real world observation that productivity growth in manufacturing is much faster than those in the services sectors. We run the model forward for 100 years and report the sectoral and aggregate TFP growth paths. The sectoral TFP growth rates in value added are calculated as the Solow residue by deducting from the sectoral growth rates in value added the weighted average of sectoral labour and capital growth rates. As our analytical analysis suggests, the TFP growth rates should converge to the sectoral rates of technical progress. This is indeed confirmed by the simulation results as depicted by Figure 1.



However, calculation of the sectoral TFP growth rates in output is not straightforward. In Oulton's study, as in many other applied studies on growth accounting, equation (2) is used to derive the TFP growth rates in output from the counterparts in value added. However, as our equation (16) illustrates, that method may be a poor approximation. Nevertheless, equation (16) is also obtained under some special assumptions and thus is not necessarily a better alternative. Therefore, here we adopt the simpler method of equation (2). The TFP growth paths are shown in Figure 2.

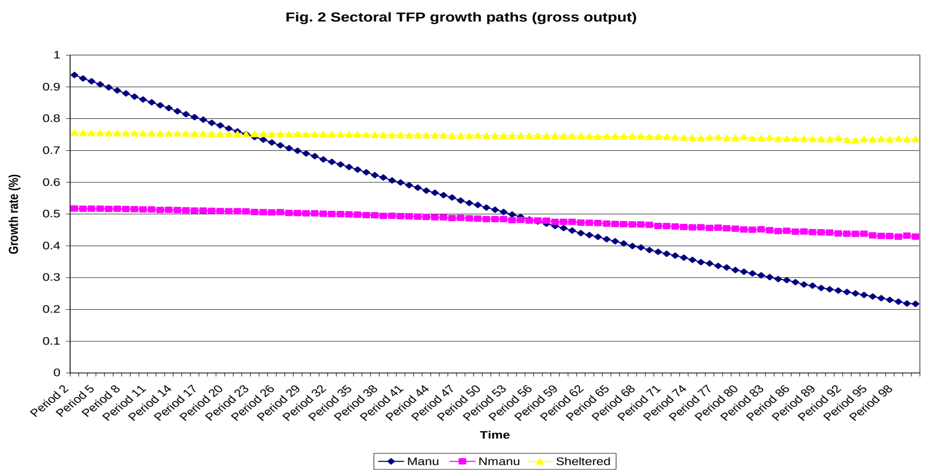
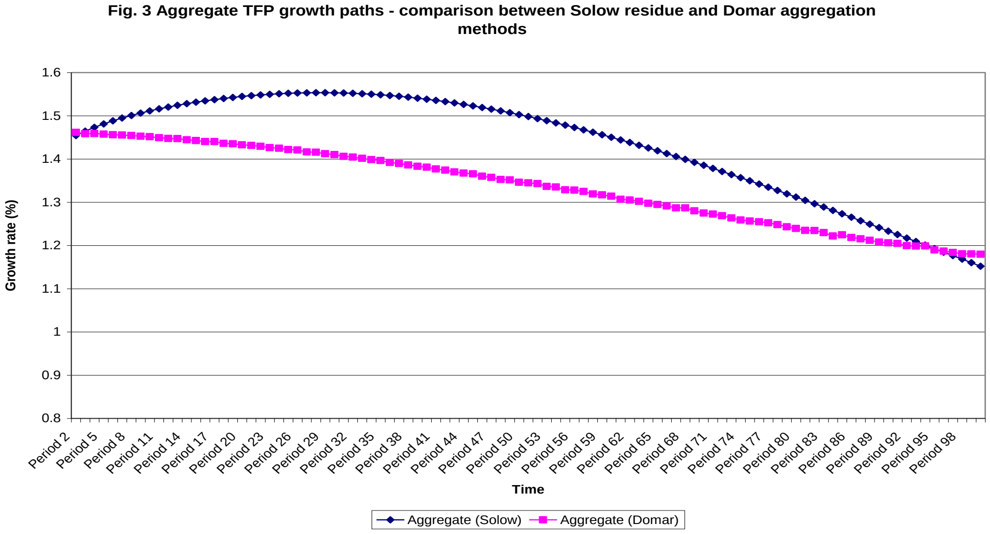


Figure 2 clearly confirms our analytical result that the TFP growth rates in output are lower than the TFP growth rates in value added. A prominent feature of Figure 2 is that despite the much superior TFP growth in value added, TFP growth in output in Manufacturing suffers a monotonic decline to levels that are significantly lower than those in the other two sectors. Before we discuss the sectoral issues further, we examine whether the growth paths obtained by applying equation (2) are a reasonable approximation. This can be done by comparing the aggregate TFP growth paths that are obtained by two alternative methods: one being the Solow residue method using the aggregate data and the other being the Domar aggregation method using the sectoral data (as in equations 2 and 3) respectively. The two aggregate TFP growth paths are shown in Figure 3.



Clearly there are significant differences between the two methods. Apart from the very long-run in which the two methods produce very similar results, the Domar method significantly under-estimates the aggregate TFP growth rates. The Domar method also fails to capture the rich dynamics of aggregate TFP over the short- to medium-run. Since in our model the differences between the short-run and the long-run are mainly due to the extent of factor mobility and the speed of adjustment in capital stocks, we argue that the Domar method is a poor approximation in situations where 'market imperfections' are significant. In applied studies on growth accounting, the derivation of aggregate TFP growth rates on the basis of sectoral data could be rather misleading, particularly if the study is over the short- to medium-term.

We now focus on the economic significance of the sectoral and aggregate TFP growth paths. A number of conclusions can be drawn from the simulation results. First, the optimist view is clearly rejected – in the long run the TFP growth path eventually converges to that of the slowest growing sector. Second, although the stagnationist view seems to be vindicated in the very long-run, the convergence process is very slow and non-monotonic. Unbalanced growth with manufacturing leading the league table of productivity performance will lead to the TFP accelerating for over three decades before it turns to settle on a long and slow declining path.

Further understanding of the adjustment process in the economy can be gained from the inspection of the changing patterns of the sectoral terms of trade and resource shifts.

Fig. 4 Sectoral terms of trade

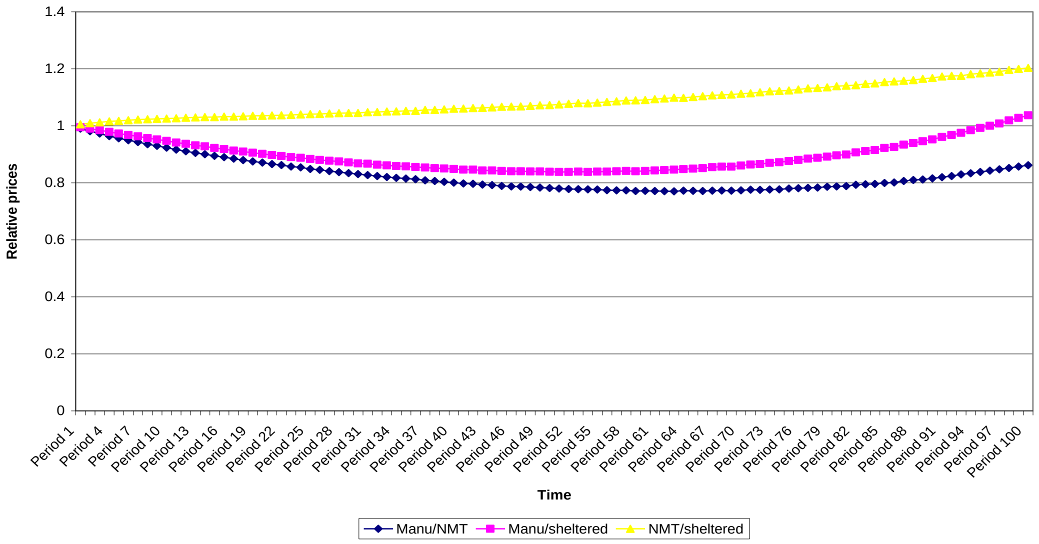
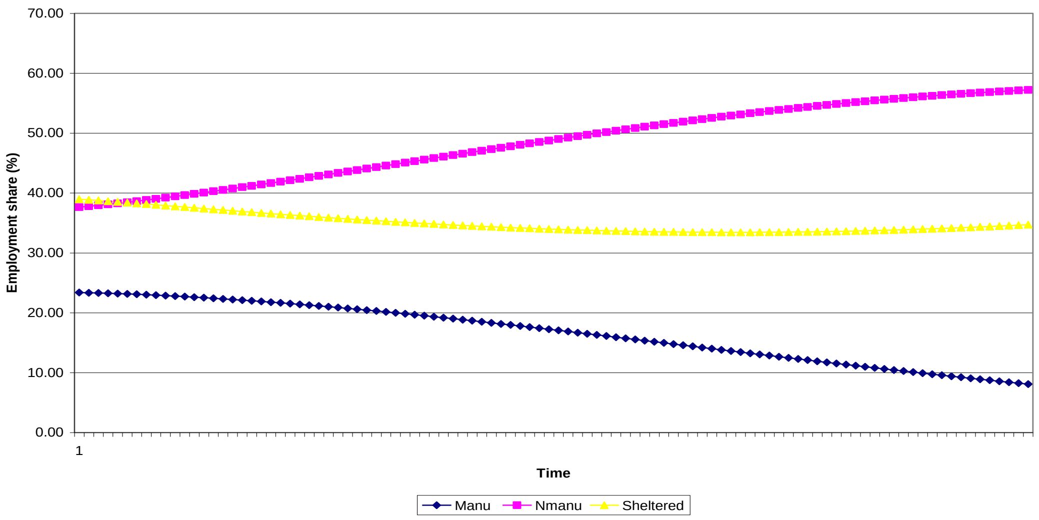


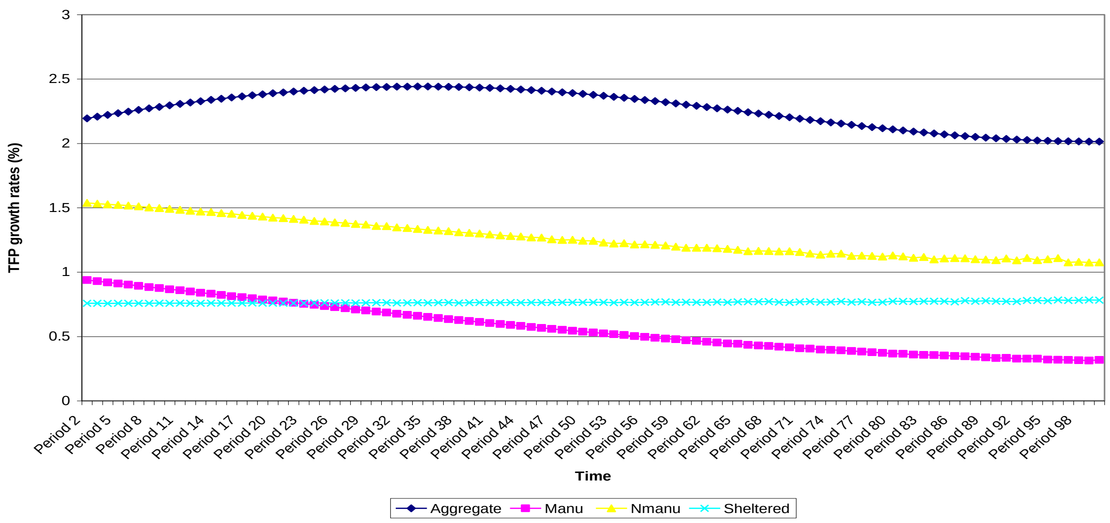
Fig. 5 Sectoral employment share



As a result of the faster productivity growth in manufacturing, manufacturing product prices become cheaper compared with the other products, so its terms of trade vis-à-vis the other two sectors both deteriorate initially. This deterioration continues for a very lengthy period before the situation reverses and manufacturing's terms of trade with the other two sectors start to improve. By the end of the simulation period, the manufacturing/sheltered terms of trade actually exceeds the starting level, although that between manufacturing/NMT never recovers to the starting level. Interestingly, the NMT sector is gaining terms of trade over the sheltered sector continuously. These changes in the terms of trade encourage resources to shift away from manufacturing to the other sectors. In fact, the NMT sector is the only gainer of employment share, as the sheltered sector also loses its share slightly (this sector is losing terms of trade not only against NMT, but also Manufacturing). This pattern of employment change seems to resemble remarkably what has been observed in the real world! Contrary to the optimist view, the continuous shift of resources to the NMT (and thus BFS) sectors can only sustain a limited period of acceleration in TFP growth before stagnation eventually sets in. Moreover, even when the TFP growth is at its peak level, it is still substantially lower than the level suggested by Oulton.

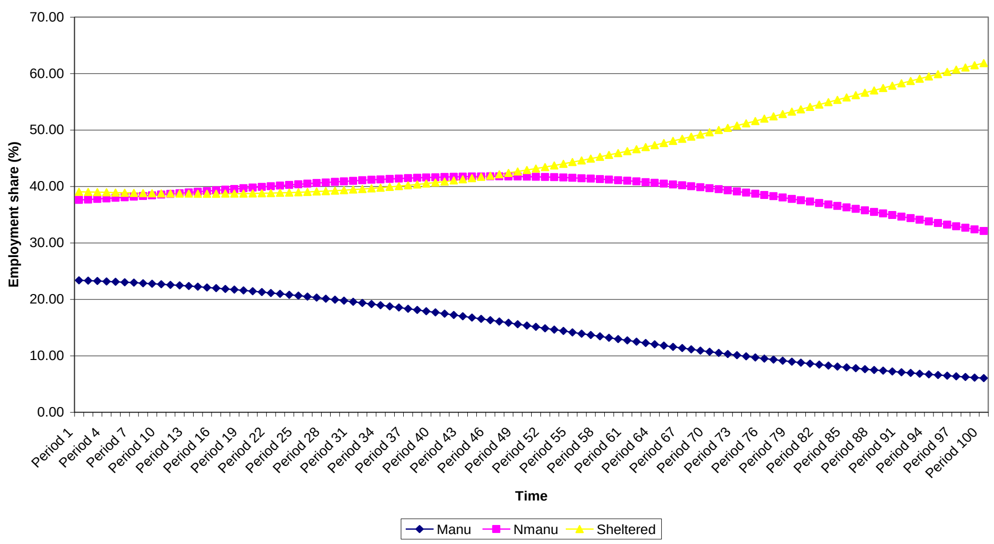
Some optimists argue that the contribution by BFS to aggregate TFP growth has not received due credit since the productivity growth rate in BFS is typically underestimated as a result of the problem in measuring service outputs. Therefore, in the second simulation, we assume 3% technical progress in both the manufacturing and NMT sectors but still 1% technical progress in the sheltered sector. The resulting productivity growth paths are depicted in Figure 6.

Fig.6 TFP growth paths (manufacturing and NMT leading)



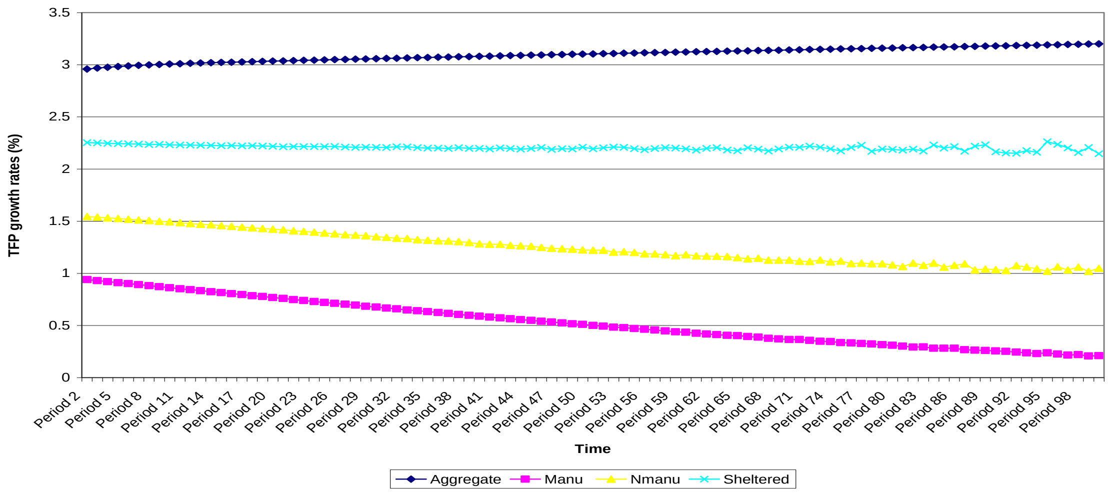
The simulation results show that despite the substantial productivity growth in both the manufacturing and NMT sectors, the aggregate TFP growth rate will reach a maximum of around 2.44% and then eventually drops to around 2%, less than 1% above the final steady-state aggregate TFP growth rate in the above scenario. Therefore, we can tentatively conclude that even if the productivity growth in BFS were substantial, it would not make a significant difference to the steady-state aggregate TFP growth rate in the economy. On the face of it, this result looks puzzling. However, it is worth noting that a sector's linkage with the rest of the economy is not restricted to intermediate linkage only, but also linkages through final sales and contribution to national income (wages and profits). Sales to final demands accounted for 83% of the sheltered sector's output (see Table 4) and this sector also had the largest share of employment (39%) at the start of the simulation period. Therefore, slow productivity growth in that sector acts as a heavy drag on the aggregate TFP growth even though the other sectors experience far superior productivity performance. As Figure 7 shows, faster technical progress in the other two sectors will cause resources to shift from those sectors to the sheltered sector. The trend in resource shift does not appear to subside even by the end of the simulation period.

Fig. 7 Sectoral employment share (manufacturing and NMT leading)



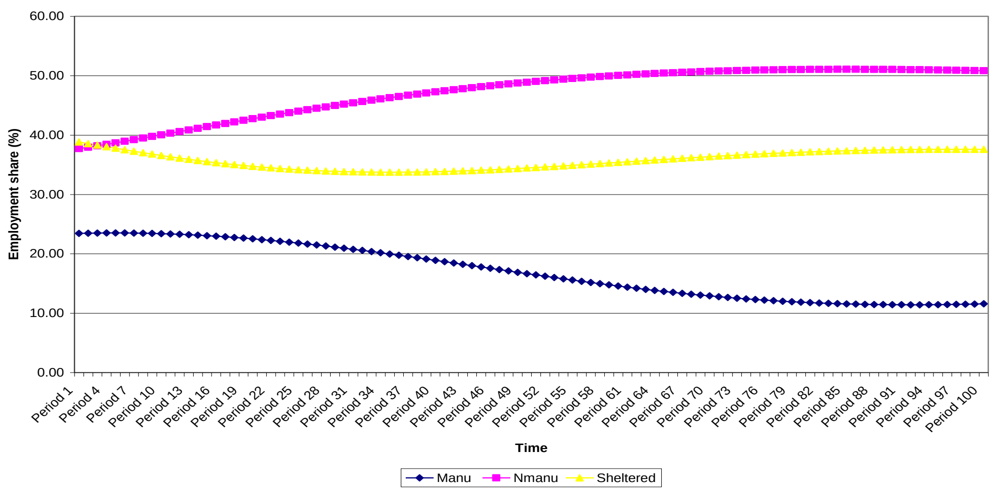
Therefore, in the next simulation, we introduce a balanced growth scenario of 3% technical progress to all three sectors. Although this is an unlikely scenario in the real world given the generally poor productivity performance in public and other private services, the intention is to see what a difference it would make if productivity in this sector were to improve. The simulated growth paths are given in Figure 8.

Fig.8 TFP growth paths (balanced growth)



Clearly, balanced productivity growth in all sectors generates a very strong aggregate TFP growth path, which reaches 3.2% at the end of the simulation period. It is worth noting that even though technical progress is balanced across sectors, but the resultant TFP growth in output is very different in different sectors. Although the TFP growth rate in the sheltered sector remains stable at around 2.2% throughout the simulation periods, the other sectors all suffer from a monotonic decline in the TFP growth rate in output. Nevertheless, the trend in resource shift eventually stops with employment shares in all sectors stabilising toward the end of the simulation period.

Fig. 9 Sectoral employment share (balanced growth)



A further simulation with a hypothetical scenario where the sheltered sector enjoys 3% technical progress whilst the other two sectors only manage 1% shows that the aggregate TFP growth path is enhanced most significantly out of all the unbalanced growth scenarios that we have examined above. Therefore, it appears that factor productive improvement in the sheltered sector brings the most significant marginal improvement to overall productivity growth. This result runs against the common perception that sectors with strong industrial linkages with the rest of the economy have also strong influence on the overall productivity performance.

6.3. Discussion and tentative conclusions

We have extended the Uzawa two-sector-two-factor growth model to incorporate intermediate linkage and unbalanced sectoral technical progress. As in the original Uzawa model, there is no guarantee that unbalanced sectoral technical growth will lead to a unique and stable overall growth path for the economy. We rely on an applied general equilibrium MSG model to simulate the aggregate TFP growth paths in order to shed light on the debate between the conventional stagnationist view and the modern optimist view. The simulation results on the one hand emphatically reject the optimist view that any positive growth in BFS productivity will lead to acceleration in the total productivity growth. On the other hand, the simulation results tend to confirm the traditional stagnationist view that slower productivity growth in BFS and other services will eventually lead to overall stagnation. However, the process of converging to stagnation is not monotonic and very slow.

The exact mechanism underlying the above findings is still unknown and may be related to the initial relative factor intensity in each sector as well as a sector’s linkage to the final market. Nevertheless, there seems to be little correlation between a sector’s industrial linkage or its role as an intermediate service provider and the effect of its productivity performance on the overall growth rate. For example, the sheltered sector has the weakest linkage with the rest of the industrial sectors, but any improvement in its technical progress has the strongest impact on the overall growth rate. This result is contrary to the conventional literature on the identification of “the engine” of economic growth that is based on the analysis of the industrial linkages of economic sectors. Technically progressive sectors do seem to lose the share of resources to the technically stagnant sectors and overall TFP growth rate does seem to slow down eventually. A more speculative conclusion is that the effort to identify ‘the engine’ of economic growth may be completely futile. However, it must be borne in mind that such conclusions have been derived from a framework that has completely ignored the endogenous growth mechanisms. Incorporation of such mechanisms explicitly into the general equilibrium MSG model remains a challenge.

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