

# Structural change and Europe's Golden Age\*

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May 20, 2001

## Abstract

Most of the countries of Western Europe grew at unprecedented rates from the late 1940s until the early 1970s. Another feature of this period was dramatic structural change, as employment shifted from agriculture to manufacturing and services. This paper uses growth accounting to measure the direct contribution of structural change to aggregate productivity growth. The conventional accounting framework is extended and then applied to Western Europe and the USA for the period 1950-1990. The paper quantifies the importance of structural change in explaining the Golden Age, the productivity slowdown, and the cross-country variation in post-war growth rates.

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\*My interest in the topic of this paper is due to Peter Temin's excellent Hicks Lecture in Oxford in March 1998. I am also grateful to Bryan Graham, John Muellbauer, Stephen Redding, Xavier Sala-i-Martin, Pierre Sicsic, David Vines, and seminar participants in Oxford and Barcelona for helpful comments and discussion. Any errors are my responsibility.

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# 1 Introduction

Most of the economies of Western Europe grew at unprecedented rates from the late 1940s until the early 1970s. Another feature of this period was a dramatic shift in patterns of employment, as the agricultural sector declined in relative importance and employment in other sectors increased. It is often argued that this structural change played an important role in the ‘Golden Age’ of growth, 1950-73. In this paper, I will extend the existing framework for analysing such questions, and present new evidence on the importance of structural change for the years 1950-1990.

In examining post-war growth, we would ideally like to have a story that could explain not only the Golden Age, but also the subsequent productivity slowdown and the wide cross-country variation in growth rates. As Temin (1999) has recently argued, structural change seems a strong candidate. The influential contributions of Kaldor (1966) and Kindleberger (1967) emphasised the importance to growth of an abundant supply of labour, based on the release of workers from the agricultural sector. The same idea can also help to explain the productivity slowdown, at least in its European guise, since the effect of labour reallocation will have diminished over time.

Structural change may also help to explain some of the striking differences in growth performance noted by most observers of Western Europe in the post-war period. The reason is that the effects will have been greatest for those countries with relatively large agricultural sectors at the start of the 1950s. For those countries which had already reallocated labour from agriculture by the 1950s, like Belgium and the UK, relatively slow growth may be easy to explain.

The potential importance of this can be seen from Figure 1. This figure is a plot of agriculture’s share in employment for the USA and the five major economies of Western Europe, for the period 1950-90. The figure shows the marked differences across countries in the extent of post-war structural change. There are dramatic changes in employment structure for some countries (notably for Italy and Spain) and relative stability elsewhere (the UK and USA).

The case of the UK may be of particular interest, since the origins of its slow post-war growth have been the subject of much debate, surveyed by Bean and Crafts (1996). The central argument of one of the best known contributions, that of Kaldor (1966), is precisely that the UK’s reallocation of labour from agriculture occurred well in advance of that in most other European countries, with implications for relative performance.<sup>1</sup> Kaldor also predicted that the exhaustion of reallocation effects would eventually lead to a growth slowdown for other countries.

The potential importance of structural change in explaining Europe’s ‘Golden Age’

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<sup>1</sup>He later modified his views and gave more emphasis to the traded goods sector, but the original idea retains some influence.

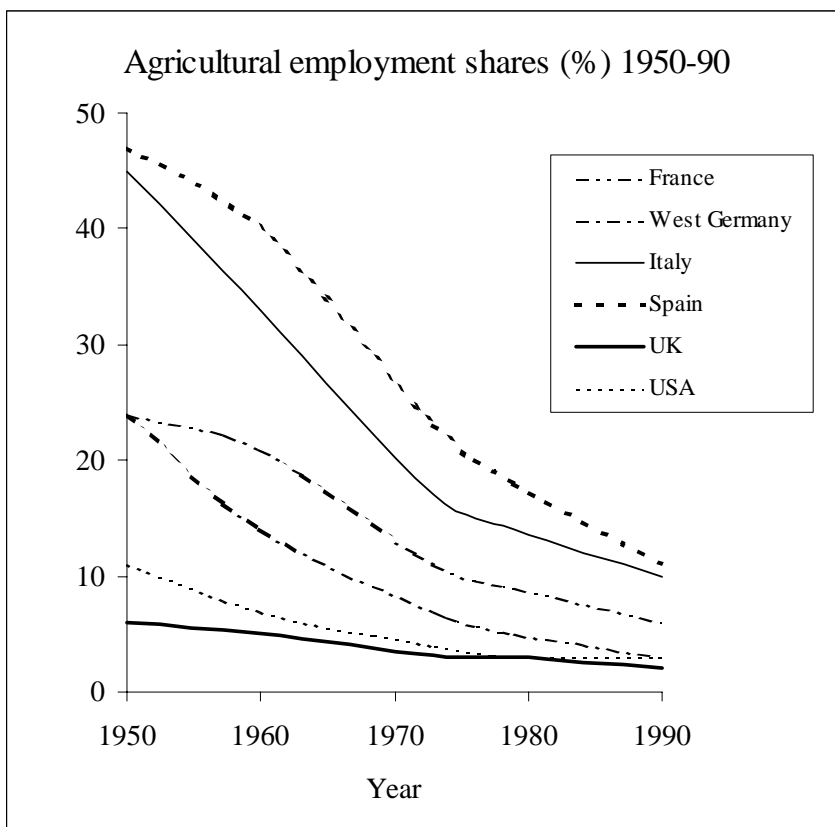


Figure 1: Agricultural employment shares (%) 1950-90

of rapid growth, the productivity slowdown of the 1970s, and the cross-country variation in growth rates, suggests that the idea deserves renewed attention. With this in mind, I extend the growth accounting frameworks that are traditionally used to analyse the direct contribution of structural change to growth. The extended approach is then used to derive new results for the period 1950-1990 for the USA and the major economies of Western Europe.

The growth accounting approach to structural change is based on the idea that the marginal product of labour differs across sectors. Reallocation of labour from a sector where labour has low marginal productivity, to one where productivity is higher, will raise aggregate total factor productivity (TFP). Unfortunately, attempts to quantify this effect are usually based on guesswork about the size of the marginal product differential or wage gap.

A key innovation of this paper is to show that readily available data can be used to place approximate bounds upon the differential. This allows me to derive estimates of reallocation effects that should be more reliable than those previously available. To

explore this further, I will contrast my method and results for the 1950s with those in the classic work of Denison (1967). I also examine the relation between my estimates and those obtained by Temin (1999) using a regression-based approach.

To anticipate the main results, I find that Denison's original estimates of the reallocation effect for the 1950s may not be too far off the mark. My new results for later periods suggest that structural change explains a significant fraction of high growth rates in some of the major European economies, and especially for West Germany, Italy and Spain. Taken as a whole, the new calculations in the paper allow a relatively precise assessment of the importance of structural change in explaining the rapid growth of the Golden Age, the cross-country variation in post-war growth rates, and the widespread slowdown in growth of the 1970s.

This is an ambitious goal, and some qualifications are necessary. It is easy to misinterpret results on the role of structural change, especially given the relatively narrow focus of the growth accounting approach to these questions. It is essential to emphasise that my work measures only one part of the contribution of structural change, namely its contribution to the TFP residual obtained by growth accounting at the aggregate level. The paper does not provide a complete analysis of the overall importance of structural change.

With this in mind, I will refer to my approach as capturing the 'direct' contribution, to differentiate it from the wider role of structural change as a 'passive' or permissive factor that enables growth to take place. This wider role is what many people have in mind when thinking about structural change and growth. It can be studied using shift-share analysis and variants upon it, as in the recent work of van Ark (1996), Broadberry (1997, 1998) and Maddison (1996). A typical use of this approach is to describe the path that output would have taken in the absence of structural change. This counterfactual is informative for a set of questions somewhat different from those emphasised here (though sometimes overlapping).

The present paper is much closer in spirit to Kuznets (1961) and Denison (1967). It restricts attention to the direct effect of structural change on aggregate productivity. This is of interest not least because estimates of TFP growth are often regarded as a 'measure of our ignorance' (Abramovitz 1956). To reduce this ignorance, we might think of separating aggregate TFP growth into a number of sources, as in Denison's work. One of these sources is the reallocation of labour from a sector where it has low productivity at the margin (typically agriculture) to a sector where marginal productivity is higher. By seeking to measure this effect more precisely, the paper contributes to our understanding of aggregate growth in TFP, and thus to our understanding of overall growth performance.

The decision to focus on structural change and aggregate TFP growth also justi-

fies the use of a two-sector disaggregation, into agriculture and non-agriculture. Again following Kuznets (1961) and Denison (1967) this is a conventional choice when examining the direct productivity effect of reallocation. To see why, recall that the effect crucially depends on a differential in the marginal product of labour across sectors. Since farm and non-farm activity typically take place in different geographic regions, a high wage differential is more likely to be sustained across agriculture and non-agriculture than it would be across other sectors.

One remaining qualification is necessary. The paper is squarely in the tradition of growth accounting and as in other such exercises, there is much that I take as given, and beyond the scope of the present analysis. The paper quantifies the effect of structural change in the presence of a marginal product differential, but this exercise is silent on the origins of both the differential and the observed shift in employment. I will take the change in the structure of employment as given, in exactly the same way that growth accountants take growth in capital or labour inputs as given.

This means that, as with all work in the growth accounting tradition, the story must be acknowledged as incomplete. Ultimately we would like to identify the forces, such as trade liberalisation or technological catch-up, that are responsible for opening up an intersectoral marginal product differential and initiating structural change. Temin (1999) has started to explore some of these issues, and it is an interesting area for further work.<sup>2</sup>

The structure of the remainder of the paper is as follows. Section 2 will show how labour reallocation forms one component of growth in aggregate productivity. Section 3 uses this framework to analyse the method of Denison (1967). Section 4, the most innovative part of the paper, shows how available data can be used to place bounds on the differential in marginal products across sectors. Section 5 provides information on the data used and the main assumptions, before section 6 presents new estimates of reallocation effects for 1950-90. Section 7 provides a summary and some conclusions.

## **2 Measuring the labour reallocation effect**

In this section, I will briefly describe the measurement of labour reallocation effects, in terms of their contribution to growth in aggregate total factor productivity. The next section will then show how Denison's calculations can be interpreted in the light of this framework.

The approach I adopt makes the traditional division of activity into an agricultural sector and a non-agricultural or 'modern' sector. In each sector, I assume that there

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<sup>2</sup>The kind of areas that might be discussed include the role of the Common Agricultural Policy, which may have slowed the reallocation of labour from agriculture, and immigration, which may have permitted faster adjustment in patterns of employment for some countries.

is an arbitrary number of profit-maximising, perfectly competitive firms.<sup>3</sup> Production takes place under constant returns to scale, and we need only consider the maximisation problem of a representative firm in each sector. Production makes use of just two inputs, capital and labour; I will discuss the possible role of land later on. The production functions are:

$$\begin{aligned} Y_a &= A_a F(K_a, L_a) \\ Y_m &= A_m G(K_m, L_m) \end{aligned} \quad (1)$$

where  $Y_a$  is agricultural output,  $K_a$  the capital stock in agriculture,  $L_a$  employment in agriculture,  $A_a$  is a productivity parameter, and the subscript  $m$  denotes the same quantities for non-agriculture. Total employment and capital will be denoted  $L$  and  $K$  respectively.

The agricultural good is the numeraire. The relative price of the non-agricultural good is assumed to be fixed at  $p$ . I will assume that workers in both sectors are paid the value of their marginal products, given by:

$$\begin{aligned} w_a &= A_a F_L \\ w_m &= p A_m G_L \end{aligned}$$

where the subscript  $L$  on  $F$  and  $G$  denotes the derivatives with respect to labour input. A key variable in much of what follows will be the marginal product differential, defined as:

$$d = w_m/w_a \geq 1$$

I assume that capital is perfectly mobile across sectors, so that we always have:

$$p A_m G_K = A_a F_K = r \quad (2)$$

Denote the share of agricultural employment in total employment by  $a = L_a/L$ , and the employment share of non-agriculture by  $m = L_m/L = 1 - a$ . The share of labour in national income is  $\eta$ .

In deriving the reallocation effect, it will be useful to define a variable  $\phi = w_a L/Y$ , which is roughly equal to the share of labour in national income. We can now write down an equation for the aggregate labour share  $\eta$  that will be useful later:

$$\begin{aligned} \eta &= \frac{w_a L_a + w_m L_m}{Y} \\ &= [a + d(1 - a)] \phi \end{aligned} \quad (3)$$

$$= [1 + (d - 1)(1 - a)] \phi \quad (4)$$

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<sup>3</sup>Ideally the modelling of the agricultural sector would be based on rural households rather than firms. I will return to this point later in the paper.

Output is given by:

$$Y = Y_a + pY_m$$

Hence we can write output growth as:

$$\frac{\dot{Y}}{Y} = \frac{\dot{Y}_a}{Y} + p\frac{\dot{Y}_m}{Y} \quad (5)$$

Based on the assumptions set out above, Appendix 1 shows that output growth can be separated into a weighted average of growth in capital and labour, a weighted average of total factor productivity growth within each sector, and a labour reallocation term. This reallocation term is the direct contribution of structural change to growth in total factor productivity at the aggregate level.

The appendix also shows that the reallocation component of the aggregate TFP growth rate can be expressed as:

$$(d-1)(1-a)\phi\frac{\dot{m}}{m}$$

or alternatively as:

$$\left[ \frac{(d-1)(1-a)}{1+(d-1)(1-a)} \right] \eta \frac{\dot{m}}{m} \quad (6)$$

where  $d$  is the ratio of marginal products in the two sectors,  $a$  is the share of agricultural employment in total employment,  $\eta$  is labour's share in national income, and the term  $\dot{m}/m$  is the rate of growth of non-agriculture's share of employment.

The effect of labour reallocation on aggregate TFP growth, captured by (6), has been derived by many authors and has appeared in a number of guises. Barro (1999) cites Kuznets (1961) as one of the first people to derive an expression equivalent to (6).<sup>4</sup> In terms of the current notation, Barro writes the reallocation effect as:

$$\frac{L_m}{L} \frac{L_a}{L} \frac{L}{Y} (w_m - w_a) \left[ \frac{\dot{L}_m}{L_m} - \frac{\dot{L}_a}{L_a} \right]$$

Some straightforward algebra shows that this is just an alternative formulation of (6). It is also possible to show that a reallocation term of the form (6) is essentially equivalent to the expression derived by Sicsic and Wyplosz (1996, p. 221-222) in discrete time.

Writing the expression in the form (6) has a significant advantage, in that it clarifies the data and parameters required to estimate the reallocation effect - namely, the magnitude of the marginal product differential, the share of labour in national income, and the share of agricultural employment in total employment. Later in the paper, it will be these quantities that are used to calculate reallocation effects.

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<sup>4</sup>See also Robinson (1971) and Syrquin (1984, 1986).

Another point to note is that we can derive an exact upper bound on the size of the reallocation effect: as the marginal product differential tends towards infinity, the magnitude of the reallocation effect tends towards  $\eta\dot{m}/m$ . In practice, I will derive an alternative and more informative upper bound on the reallocation effect, based on a technique that will be described in section 4 below.

It remains interesting to note one further implication of (6). The form of the equation implies that, as the differential increases, the size of the reallocation effect becomes less and less sensitive to changes in the differential. This suggests that calculations of the reallocation effect are potentially informative, even given the inevitable uncertainty about the true magnitude of the marginal product differential.

Some key assumptions implicit in the framework above should be noted. I have treated the agricultural sector as a group of firms, but arguably a more attractive model would be one that started from the maximisation problem of agricultural households, and that allowed income sharing. This could incorporate the possibility that agricultural labour is paid its *average* product, so that the differential between *marginal* products will be greater than the observed ratio of non-agricultural incomes to those in agriculture. To some extent, I will take this into account in making assumptions about the likely magnitude of the differential. A more rigorous extension would be to incorporate rural households explicitly, but this would add to the complexity of the analysis, and it is also possible that such a model would be hard to take to the available data.

Another attractive generalization would be to allow wages to differ from marginal products, not simply due to income sharing, but also to imperfect information and market failures. Again, however, it is difficult to integrate this idea into the standard growth accounting framework. Given my assumption of constant returns to scale, the payment to factors of their marginal products will exhaust output. If factor payments diverge from marginal products, a new theory of distribution is needed, and rendering this consistent with the framework of representative firms and constant returns is not straightforward. I will restrict attention to the simpler case, and so the remainder of the paper treats the terms ‘marginal product differential’ and ‘wage differential’ as essentially interchangeable.

The implicit assumptions about the use of land are less strong. To keep the distribution theory simple, one might want to assume constant returns to scale in capital, labour and land. Since there are no longer constant returns to capital and labour, the coefficients on the growth rates of capital and labour will no longer sum to one, when applying growth accounting at the aggregate level. Although this will affect the derivation of growth in aggregate total factor productivity (as will any increase or reduction in farmland) it does not change the magnitude of the calculated reallocation effect. Hence the calculations in this paper are potentially quite robust to alternative assumptions



about the role of land.

### 3 Denison's approach

In this section, I will briefly set out the calculations used in the classic work of Denison (1967) to estimate the size of labour reallocation effects. His presentation is a little opaque, and so I will show how his method is related to the analysis of the previous section, and provide a consistent interpretation in terms of sectoral production functions. A significant gain from this exercise is to clarify the nature of Denison's assumptions about the marginal product differential, which are left implicit in his calculations.

Denison (1967) sets out his approach in chapter 16. It is possible to infer the details of the method from his Table 16-8 and the accompanying text. For each country that he considers, he calculates an effect of labour reallocation on total factor productivity growth using an equation of the form:

$$DENADJ = (1 - s)x\frac{\dot{m}}{m} + sy\frac{\dot{a}}{a} \quad (7)$$

where the agricultural employment share is denoted by  $a$ , and  $m = 1 - a$  is the modern sector employment share, as before. The share of agricultural output in total output is denoted by  $s = Y_a/Y$ .

Crucial elements of this calculation are  $x$  and  $y$ , two country-specific parameters chosen by Denison. Roughly speaking,  $x$  captures the output benefit associated with an additional worker in the modern sector, expressed as a percentage of modern sector output per worker. More precisely,  $x$  is the elasticity of modern sector output with respect to labour. Denison (1967, p. 212) assumes that  $x$  is 0.75 for the USA and Italy, and 0.8 for the other countries he considers.

Similarly,  $y$  is the output elasticity in agriculture. Denison (1967, p. 214) assumes that  $y$  is 0.33 for Denmark, the UK, and the USA; zero for Italy; and 0.25 for the remaining countries. The assumption for Italy reflects his view that "...the gains from consolidating farms and plots have been so great in Italy that the reduction in farm labor has no adverse long-run effect on farm output" (p. 214). In other words, Denison assumes that the marginal product of labour was effectively zero in Italian agriculture in the 1950s.

We can show the relation of the Denison approach to that of section 2 as follows. First, it will be helpful to write down two equations which link the sectoral labour shares to the variable  $\phi$  and the agricultural output and employment shares. The share of labour in agricultural value added,  $\eta_a$ , can be written as:

$$\eta_a = \frac{w_a L_a}{Y_a} = \frac{w_a a L}{sY} = \frac{\phi a}{s} \quad (8)$$

Similarly, the share of labour in modern sector value added  $\eta_m$  is:

$$\eta_m = \frac{w_m L_m}{pY_m} = \frac{dw_a(1-a)L}{(1-s)Y} = d\phi \left( \frac{1-a}{1-s} \right) \quad (9)$$

We are now in a position to reformulate the Denison adjustment:

$$\begin{aligned} DENADJ &= (1-s)x \frac{\dot{m}}{m} - sy \frac{\dot{m}}{m} \frac{m}{a} \\ &= \left[ \left( \frac{1-s}{1-a} \right) x - \frac{s}{a} y \right] (1-a) \frac{\dot{m}}{m} \\ &= \left[ \frac{d\phi}{\eta_m} x - \frac{\phi}{\eta_a} y \right] (1-a) \frac{\dot{m}}{m} \end{aligned}$$

By imposing  $x = \eta_m$  and  $y = \eta_a$  we can rewrite this as:

$$DENADJ = (d-1)(1-a)\phi \frac{\dot{m}}{m}$$

which is exactly the reallocation term derived earlier. On this interpretation, Denison is making similar assumptions to those in section 2 above. His assumptions on the parameters  $x$  and  $y$  can be interpreted as assumptions about the sectoral factor shares,  $\eta_m$  and  $\eta_a$ , in the context of profit-maximising firms. This is just the usual growth accounting connection between output elasticities and factor shares, under constant returns to scale and perfect competition.<sup>5</sup>

Yet as the assumptions about Italy make clear, Denison seems to have had in mind a more complex framework, in which labour was more likely to be drawn from relatively unproductive farms. This kind of consideration leads him to separate the sectoral output elasticities from the sectoral factor shares. One consequence is that, within the framework of this paper, Denison's assumptions are inconsistent with his data on aggregate labour shares. We can write the labour share ( $\eta$ ) as:

$$\begin{aligned} \eta &= \frac{w_a L_a + w_m L_m}{Y} \\ &= \frac{Y_a}{Y} \frac{w_a L_a}{Y_a} + \frac{pY_m}{Y} \frac{w_m L_m}{pY_m} \\ &= s\eta_a + (1-s)\eta_m \end{aligned}$$

Arguably Denison should have chosen the output elasticities ( $x = \eta_m$  and  $y = \eta_a$ ) individually for each country, to be consistent with the aggregate labour share in the national accounts ( $\eta$ ). It is clear that to justify his approach rigorously would require

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<sup>5</sup>This link is more explicit in Denison and Chung (1976, p. 226-227) and Scott (1989, p. 539). In their study of growth in Japan, Denison and Chung adopt the labour share in non-agriculture as the output elasticity in that sector, but adopt an elasticity for agriculture that is lower than the agricultural labour share.

a more general and complex theoretical framework, probably with substantial heterogeneity across farms.

Staying with the simpler approach, we can now examine the implicit assumptions about the extent of the marginal product differential,  $d$ . By combining equations (8) and (9) we can derive:

$$d = \frac{\eta_m}{\eta_a} RLP = \frac{x}{y} RLP$$

where the new variable  $RLP$  is the ratio of the average product of labour in the modern sector to that in agriculture, and is given by:

$$RLP = \frac{1-s}{s} \frac{a}{1-a}$$

Since Denison assumes that  $x > y$ , in effect he assumes that the ratio of marginal products across the two sectors is greater than the ratio of average products, itself often large.

## 4 Deriving bounds on the differential

Estimates of labour reallocation effects may be sensitive to assumptions about the extent of the marginal product differential or wage gap. Denison's calculations, based on guesswork about output elasticities, turn out to imply a very large wage differential for some countries. One of the main new contributions of this paper is to show how data on agricultural output and employment shares can be used to derive bounds that must be satisfied by the 'true' wage differential. This section sets out the key ideas.

The approach works by exploiting accounting identities. The starting point is the two equations for the sectoral factor shares, (8) and (9). They can be written in terms of agricultural output and employment shares, the aggregate share of labour in national income ( $\eta$ ) and the wage differential ( $d$ ) as well. This means that, if we place bounds on the sectoral factor shares, we can also obtain bounds on  $d$ , the differential.<sup>6</sup> The sectoral factor shares must lie between zero and one, which immediately gives a range of possible values for  $d$ . More restrictive assumptions on the two factor shares yield tighter and hence more informative bounds.

This result has not been previously observed to my knowledge, perhaps because the intuition is not immediately apparent. To see how the idea works, take the aggregate labour share as fixed by the data, together with the agricultural output and employment shares. With the aggregate labour share fixed, together with the employment and output share of each sector, then a greater wage differential means that labour income in the modern sector must account for a relatively large share of total labour income. In turn,

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<sup>6</sup>Bounds on the sectoral factor shares are adopted since the exact values are typically not available in national accounts, at least for the period analysed in this paper.

this must require a greater share of labour income in modern sector income, and a lower share of labour in agricultural income. By placing upper and lower bounds that must be satisfied by these sectoral labour shares, we can derive upper and lower bounds that must be satisfied by the true wage differential.

This can be demonstrated more formally. Consider bounds on the sectoral labour shares, starting with the agricultural labour share ( $\eta_a$ ):

$$\begin{aligned}\lambda_L &< \eta_a < \lambda_H \\ \lambda_L &< \frac{\phi a}{s} < \lambda_H \\ \lambda_L(a + d(1 - a)) &< \frac{\eta a}{s} < \lambda_H(a + d(1 - a))\end{aligned}$$

where the last line uses equation (3). With some rearrangement the last line implies:

$$\left(\frac{\eta - \lambda_H s}{\lambda_H s}\right) \frac{a}{1 - a} < d < \left(\frac{\eta - \lambda_L s}{\lambda_L s}\right) \frac{a}{1 - a} \quad (10)$$

which gives a lower and upper bound on the marginal product differential. The bounds are functions of the aggregate labour share ( $\eta$ ), the agricultural employment and output shares ( $a$  and  $s$ ) and the bounds on the agricultural labour share ( $\lambda_L, \lambda_H$ ). Note that the upper bound on the differential is generated by the lower bound on the agricultural labour share. It is this bound which is emphasised in the empirical work below.

The upper bound is always positive, but this is not true of the lower bound. Recall that we can write the aggregate labour share as:

$$\eta = s\eta_a + (1 - s)\eta_m \quad (11)$$

and so it must be the case that  $\eta \geq s\eta_a > s\lambda_L$ ; the upper bound is always positive. The lower bound may be negative (since it is possible that  $\eta < s\lambda_H$ ) in which case it is uninformative.

Using equation (11) we can also rewrite the bounds on  $\eta_a$  in terms of implicit bounds on  $\eta_m$ , labour's share of income in the modern sector. Alternatively, we can use explicit bounds on  $\eta_m$  to place further restrictions on the wage differential:

$$\begin{aligned}\gamma_L &< \eta_m < \gamma_H \\ \gamma_L &< d\phi \left(\frac{1 - a}{1 - s}\right) < \gamma_H \\ \gamma_L(a + d(1 - a)) &< d\eta \left(\frac{1 - a}{1 - s}\right) < \gamma_H(a + d(1 - a))\end{aligned}$$

This implies the following bounds on  $d$ :

$$\frac{a}{(1 - a)} \left[ \frac{\gamma_L(1 - s)}{\eta - \gamma_L(1 - s)} \right] < d < \frac{a}{(1 - a)} \left[ \frac{\gamma_H(1 - s)}{\eta - \gamma_H(1 - s)} \right] \quad (12)$$

where I assume that  $\eta > \gamma_H(1 - s)$ . If this condition does not hold, the second inequality in (12) is reversed and is not informative (it tells us only that  $d$  is greater than a negative number). It can be shown that the lower bound is always positive, since  $\eta \geq (1 - s)\eta_m > (1 - s)\gamma_L$  from (11) and the bounds on the factor share.

In practice this paper will make more intensive use of the bounds provided by (10) for reasons to be explained below. In effect, I will be starting from data on  $\eta$  and a set of bounds on  $\eta_a$ , which then imply bounds on the other output elasticity ( $\eta_m$ ) and also on the wage differential. Either the two output elasticities, or simply the wage differential, can then be used to calculate the reallocation effect. Within my framework these approaches are equivalent. In what follows, I will emphasise the formulation in terms of wage differentials, in the belief that readers will find it easier to interpret and assess assumptions on differentials rather than output elasticities or sectoral factor shares.

It should also be emphasised that the bounds are only approximate. Implicitly, the approach treats all labour as homogeneous. It is possible that working hours differ across agriculture and non-agriculture, in which case the employment shares used to derive the bounds mismeasure relative labour inputs. Perhaps more importantly, when workers differ in ability or education across sectors, we have much less reason to think that bounds on the wage differential obtained from national accounts data are informative. Since one might expect workers in agriculture to be less well-educated on average, the lower bound on the differential may be particularly misleading.<sup>7</sup>

Despite these various problems, the approach suggested here is likely to be a significant improvement on previous ones, especially since it is the *upper* bound on the differential that I will emphasise in the empirical work that follows.

## 5 Data and assumptions

The paper will ultimately present estimates of structural change effects for the period 1950 to 1990, for the USA and the major economies of Western Europe, and compare the results for the 1950s with those derived by Denison (1967). This section briefly describes the data and the assumptions necessary for the calculations, with a particular focus on the assumptions relating to the wage differential.

As set out in the introduction, one aim of investigating reallocation effects is to assess their role in explaining cross-country variation in growth rates. To assess the size of reallocation effects relative to growth rates will require data on output per worker or output per head for particular years between 1950 to 1990. These data are drawn from

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<sup>7</sup>Schmitt (1989) discusses some further issues that may also be relevant here, such as the treatment in the national accounts of non-farm production by agricultural households.

Maddison (1996), van Ark (1996) and OECD sources. More details can be found in the data appendix.

As we have seen, the reallocation effect can be calculated using data on the aggregate labour share and agriculture's share of employment, combined with an assumption about the wage differential. For 1950-62, I will use the data on the first two quantities provided by Denison (1967, Tables 4-1 and 16-4), to allow a clear comparison with his results. For 1950-62, there are only two departures from Denison's work. These are my assumptions about the wage differential, and a treatment of output elasticities that is always consistent with available data on the aggregate labour share.

The analysis will also go beyond Denison's work by presenting new estimates for the period 1960-90. These estimates use data on agricultural employment shares from van Ark (1996, Table A-9). Figures for the aggregate labour share are harder to obtain. The ones used here are derived from the OECD's business sector database, and are based on the share of labour in the business sector, also used by Blanchard (1997) as a proxy for the aggregate labour share. These data are shown in Table 1. Note that for several countries, the figure reported for 1960 is necessarily based on a later year. The figures for Norway are derived from national sources.

	1960s	1973	1979	1990
Belgium	0.64	0.67	0.73	0.66
Denmark	0.71	0.70	0.73	0.65
France	0.68	0.67	0.70	0.62
Italy	0.69	0.69	0.69	0.66
Netherlands	0.66	0.69	0.70	0.61
Norway	0.63	0.76	0.73	0.70
Spain	0.74	0.79	0.78	0.66
Sweden	0.72	0.70	0.73	0.73
United Kingdom	0.69	0.69	0.69	0.72
USA	0.73	0.69	0.67	0.66
West Germany	0.68	0.71	0.70	0.64

The labour share in the business sector may not match that in the economy as a whole, and the figures would ideally be adjusted for labour income from self-employment.<sup>8</sup> That said, such adjustments are unlikely to be a major source of error in the reallocation effects.

The remainder of this section discusses my assumptions about the wage differential. As we have seen, it is possible to generate restrictions that the wage differential must

<sup>8</sup>For example, Krueger (1999) argues that a measure of labour's share for the USA, when suitably adjusted for proprietors' income, has fluctuated between 75% and 80% for the entire post-war period.

satisfy, given the adoption of lower and upper bounds for at least one of the sectoral labour shares. Nevertheless, sometimes these bounds are too wide to be informative. When necessary, I will instead impose a differential at the upper end of the plausible range, with the aim of obtaining an upper bound on the importance of labour reallocation to growth.

For the countries examined in this paper, the upper bound on the differential shows considerable sensitivity to the upper bound placed on the non-agricultural labour share ( $\eta_m$ ). Given this sensitivity, I will adopt a relatively wide set of bounds on  $\eta_m$ , and rely more on the bounds on the agricultural labour share ( $\eta_a$ ). In the calculations that follow, the non-agricultural labour share is assumed to lie between 0.40 and 0.85.

This means that, in the calculations that follow, it is the upper and lower bounds for the agricultural labour share that are crucial. The choice of these bounds is guided by figures in OECD (1964a, p. 30) and the estimates of Hayami and Ruttan (1985, p. 204) of labour's share in agriculture for the USA. Their estimate for 1950 is 0.553. Given the high capital intensity of US agriculture, it seems unlikely that this figure will have been lower in Western European countries. I therefore assume that the share of labour in agricultural income was between 0.40 and 0.80 for the periods 1950-55 and 1955-62, which is also compatible with data in OECD (1964a).

The Hayami and Ruttan estimates also indicate that labour's share in agricultural income has been falling in the USA: to 0.233 by 1970, and 0.133 by 1980. Based on these figures, I assume that labour's share in agriculture was between 0.20 and 0.80 for 1960-73 and 1973-79; and between 0.10 and 0.80 for 1979-90.

These figures are also potentially consistent with evidence presented by Gollin (1998) on employee shares of compensation in agriculture in the mid-1980s. Among the countries considered here, he reports figures for Denmark (employee share 0.18), France (0.16), Norway (0.14), Spain (0.26), Sweden (0.24), and the UK (0.29). These figures are likely to understate the labour income share in agriculture, probably substantially, because they do not include adjustments for the labour income of self-employed farmers.

Nevertheless, for later periods, it does become harder to rule out low values for the agricultural labour share, and so the bounds on the wage differential become steadily less informative. When this happens, I will return to the usual method of guesswork, and the empirical work will assume that the ratio of wages in the two sectors is never greater than four. This need to rely on guesswork is not quite as serious as it may first appear. The reason is that for later periods, even assuming a ratio as high as four, the effects of reallocation are found to be small for all the countries considered except Spain and Italy. By the mid-1970s, agricultural employment was such a low proportion of total employment for most Western European countries that the scope for large productivity

gains from further reallocation was greatly curtailed.

The remainder of this section discusses my assumption that the ratio of wages in the two sectors never exceeds four. Ideally, assumptions of this kind would be explored using micro data on wage differentials across sectors, for workers of similar characteristics.<sup>9</sup> Unfortunately suitable data are sparse for most of this period. Reasonably detailed data are available for West Germany (OECD 1965, p. 49-50) but these data compare agricultural incomes only with the income of other rural workers. For 1956-63, these data suggest that farm workers typically earned about 60%-75% of the earnings of workers in rural enterprises. Given that the labour market within rural areas is likely to have been quite well integrated, it is possible that these figures reflect mainly differences in skills, rather than a genuine wage gap. Equally, these figures perhaps understate the true extent of wage differentials between rural and urban areas.

Perhaps more useful data are those available for Sweden. Using data drawn from Swedish tax records, OECD (1964b, p. 393) reports incomes for “basic” (small) farms and the incomes of comparable industrial workers, for 1956-61. These data consistently suggest that incomes in industry were about twice those in agriculture over this period.

Clearly the figures for both West Germany and Sweden should not necessarily be taken at face value, given the many difficulties inherent in comparing incomes. It is also possible that they do not provide a useful guide to wage differentials at other times and places. Finally, there is also the important possibility noted earlier, that some agricultural workers receive their average product, and that the marginal product of labour in agriculture may have been close to zero in some countries in the late 1940s.

With all these concerns in mind, I will choose to adopt the figure of four as an upper bound on the wage differential. To see why figures much higher than this might be implausible, let us assume for the moment that workers receive their marginal product in both sectors. Starting from a situation where returns to labour and capital are equal across sectors, the creation of a wage differential of four requires a very large increase in productivity in non-agriculture. Furthermore, a differential of this size can only be sustained over several years if workers are relatively insensitive to wage gaps in making choices about migration.

Together, these arguments suggest that one should limit the size of the wage differential. These same arguments also suggest that some of the differentials implicit in Denison’s calculations are too high. The nature of his assumptions will be discussed more fully in the next section.

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<sup>9</sup>In principle one could use micro data to estimate an earnings regression and include a dummy variable for working in agriculture. In practice this approach is limited by data availability considerations, given that the current analysis starts from 1950 for nine of the eleven countries considered.



## 6 Reallocation effects: new estimates

The methods outlined earlier are now used to analyse structural change and growth in Western Europe and the USA for 1950-90. The effects of reallocation are calculated for five subperiods: 1950-55, 1955-60, 1960-73, 1973-79, and 1979-90. The results for 1950-55 are compared with those of Denison (1967). Denison also looks at 1955-62, and so I will also calculate effects for this time period, and compare my results with his. For 1950-55 and 1955-62, the sample of countries is exactly the same as Denison's.

Table 2 lists the results for 1950-55. It shows the aggregate labour share in 1950 ( $\eta$ ), bounds on the wage differential, and the differential that I assume in making the calculation ( $d$ ). The result is the reallocation effect ( $R$ ) expressed in terms of an annual impact on the growth rate, in percentage points. The quoted figure is intended to form an upper bound on the importance of reallocation, in the context of the present approach. For comparison, I also present the annual rate of growth in output per worker (denoted  $G$ ), and the fraction of this growth that can be explained directly by the reallocation effect ( $R/G$ ).

One particularly interesting aspect of Table 2 is the set of bounds on the wage differential. The upper bound is relatively low in four countries: Belgium, Denmark, the Netherlands, and the UK. This tallies reasonably well with points made by Kindleberger (1967). In his chapter IV, he classifies Belgium, the UK, and the Scandinavian countries as slow growers. He points out that "Britain and Belgium among the countries of Europe have had far less room to transfer labor from agriculture to other sectors because they have long since done so" (p. 69).<sup>10</sup> For Belgium and the UK, the calculations of Table 2 indicate that the wage differential is more tightly bounded than elsewhere. These relatively narrow bounds are consistent with the view of Kindleberger that a substantial reallocation of labour had long since taken place in these countries, contributing to the disappearance of any initial differential.

Table 2 shows that the labour reallocation effect generally accounts for between a twentieth and a seventh of annual growth in output per worker. The size of the effect is striking for some countries. For 1950-55, labour reallocation is estimated to have contributed 0.69 percentage points to Italy's annual growth rate and 0.82 points to that of West Germany. This suggests that structural change can make a substantial contribution to growth in aggregate total factor productivity.

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<sup>10</sup>Although Kindleberger does not do so, one could add the Netherlands to this list.

Country	$\eta$	$d_1 < d < d_2$	$d$	$R$	$G$	$R/G$
Belgium	0.78	(1.31, 2.73)	2.7	0.21	3.11	0.07
Denmark	0.78	(1.27, 2.11)	2.1	0.25	1.91	0.13
France	0.77	(2.76, 5.94)	4.0	0.49	3.93	0.12
Italy	0.73	(1.67, 3.75)	3.7	0.69	4.79	0.14
Netherlands	0.76	(0.95, 2.06)	2.0	0.15	3.30	0.05
Norway	0.71	(3.32, 6.96)	4.0	0.52	3.75	0.14
United Kingdom	0.81	(1.25, 2.55)	2.5	0.07	1.42	0.05
USA	0.80	(2.43, 5.01)	4.0	0.26	2.65	0.10
West Germany	0.74	(2.23, 4.78)	4.0	0.82	6.69	0.12

Table 3 presents calculations for 1955-60, based on data from Denison (1967) combined with data from van Ark (1996). According to these estimates, labour reallocation accounts for around 0.8 percentage points of Italy's annual growth rate over this period. The effect is also substantial in Denmark, France and West Germany. For most countries, reallocation accounts for somewhere roughly between a tenth to a sixth of annual growth in output per worker.

Country	$\eta$	$d_1 < d < d_2$	$d$	$R$	$G$	$R/G$
Belgium	0.78	(1.24, 2.58)	2.5	0.15	2.40	0.06
Denmark	0.79	(1.48, 2.59)	2.5	0.53	3.81	0.14
France	0.78	(2.34, 5.03)	4.0	0.70	4.47	0.16
Italy	0.75	(2.09, 4.79)	4.0	0.79	5.23	0.15
Netherlands	0.77	(1.01, 2.15)	2.1	0.27	2.94	0.09
Norway	0.75	(4.81, 9.88)	4.0	0.30	3.49	0.09
United Kingdom	0.81	(1.11, 2.28)	2.2	0.00	1.64	0.00
USA	0.83	(2.44, 5.00)	4.0	0.42	1.59	0.26
West Germany	0.74	(2.12, 4.47)	4.0	0.58	4.95	0.12

Table 4 compares my estimates with a replication of the original calculations of Denison (1967) for 1950-62. The Table shows the differential implicit in Denison's calculations, for comparison with my own assumptions and the bounds shown in Tables 2 and 3. It also shows the reallocation effects ( $R$ ) calculated by Denison and myself, again in terms of a contribution to the annual growth rate.

Note, however, that the results quoted as Denison's are slightly different from those implicit in his Table 16-8. Unfortunately the data Denison uses on agricultural output

and employment shares are rounded to one decimal place when reported in Denison (1967). This leads to discrepancies between his Table 16-8 results and my replication of them, which is based on the reported data. Since the discrepancies are very minor, I have chosen to use the reported data for both sets of calculations, in order to highlight the differences between us in method and assumptions.

In looking at Table 4, one point to note is that Denison's assumed wage differentials often exceed the upper bound reported in Tables 2 and 3 for roughly the same periods. Also, his assumptions imply that the wage differential greatly varied across countries. Although there is no reason to believe that the differential was the same everywhere, it seems sensible to restrict the degree of variation in the assumptions made for different countries.<sup>11</sup>

Yet it can also be seen from Table 4 that my results for the 1950s are very close to those of Denison, despite the alternative assumptions about the differential and the adoption here of an internally consistent theoretical framework. The latter change is not unimportant, in that my reallocation effects are similar to Denison's even where I assume a lower wage differential, as in the case of the UK and the USA.

The overall similarity in results may be surprising. The explanation can be found in the form of the adjustment for labour reallocation. Equation (6) implies that the effect of varying the assumption about the differential ( $d$ ) becomes less important for relatively high values of  $d$ . This suggests that calculations like Denison's can be informative, even given the uncertainty that surrounds assumptions on intersectoral wage differentials.

Now I turn to new results, for the effects of structural change after 1960. This period goes beyond Denison's work, and for this purpose I use data on agricultural output and employment shares drawn from van Ark (1996). This also allows me to add Spain and Sweden to the nine countries previously considered.

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<sup>11</sup>One should qualify this statement somewhat. Denison's calculations implicitly make use of the ratio of average products of labour in the two sectors, to gauge the ratio of marginal products. If one knew with certainty the technology parameters of the sectoral production functions, so that one could calculate the ratio of marginal products using the ratio of average products, Denison's approach would clearly be the right way to proceed. In practice, his approach is essentially based on an educated guess about the output elasticities, as indicated in section 3 above.

Table 4  
A comparison of Denison's estimates and mine

	Denison $d$	My $d$	Denison $R$	My $R$
1950-55				
Belgium	4.33	2.7	0.24	0.21
Denmark	3.18	2.1	0.30	0.25
France	9.28	4.0	0.58	0.49
Italy	$\infty$	4.0	0.84	0.72
Netherlands	3.23	2.0	0.20	0.15
Norway	12.11	4.0	0.71	0.52
United Kingdom	3.01	2.5	0.07	0.07
USA	5.53	4.0	0.26	0.26
West Germany	7.74	4.0	0.96	0.82
1955-62				
Belgium	4.09	2.5	0.18	0.15
Denmark	3.66	2.5	0.47	0.44
France	7.69	4.0	0.66	0.60
Italy	$\infty$	4.0	1.21	0.99
Netherlands	3.39	2.1	0.22	0.17
Norway	16.49	4.0	0.42	0.32
United Kingdom	2.66	2.2	0.05	0.05
USA	5.35	4.0	0.24	0.26
West Germany	7.39	4.0	0.62	0.54

Table 5  
Reallocation effects 1960-73

Country	$\eta$	$d_1 < d < d_2$	$d$	$R$	$G$	$R/G$
Belgium	0.64	(0.91, 3.89)	3.8	0.13	4.31	0.03
Denmark	0.71	(1.49, 6.72)	4.0	0.46	3.90	0.12
France	0.68	(2.08, 9.13)	4.0	0.44	4.48	0.10
Italy	0.69	(2.81, 12.71)	4.0	0.77	5.50	0.14
Netherlands	0.66	(0.71, 3.15)	3.1	0.14	4.37	0.03
Norway	0.63	(1.35, 6.02)	4.0	0.29	3.17	0.09
Spain	0.74	(2.24, 6.45)	4.0	0.92	6.03	0.15
Sweden	0.72	(1.91, 8.15)	4.0	0.36	3.60	0.10
United Kingdom	0.69	(1.03, 4.28)	4.0	0.08	2.51	0.03
USA	0.73	(1.50, 6.23)	4.0	0.13	1.74	0.07
West Germany	0.68	(2.15, 9.09)	4.0	0.30	4.10	0.07

Table 5 shows the effects for 1960-73. The results suggest that labour reallocation continued to account for a tenth to a seventh of growth in several countries, and was

particularly important for Italy and Spain. Also note that the impact on growth in West Germany, quite large in previous periods, considerably diminished for 1960-73. By 1960 the agricultural employment share in West Germany was just 14%, and so the scope for further productivity benefits from reallocation was considerably reduced.

Table 6 reports results for 1973-79. It is possible to see that reallocation is now of little importance to several countries; it continues to play a role in raising the growth rate in Spain, and to a lesser extent in Italy.

Country	$\eta$	$d_1 < d < d_2$	$d$	$R$	$G$	$R/G$
Belgium	0.67	(0.85, 3.52)	3.5	0.05	2.21	0.02
Denmark	0.70	(1.24, 5.29)	4.0	0.19	1.74	0.11
France	0.67	(1.27, 5.46)	4.0	0.18	2.76	0.07
Italy	0.69	(1.96, 8.44)	4.0	0.29	2.37	0.12
Netherlands	0.69	(0.82, 3.44)	3.4	0.00	1.45	0.00
Norway	0.76	(1.79, 7.52)	4.0	0.20	2.75	0.07
Spain	0.79	(2.42, 7.58)	4.0	0.58	5.10	0.11
Sweden	0.70	(1.51, 6.28)	4.0	0.09	0.82	0.11
United Kingdom	0.69	(0.86, 3.55)	3.5	0.00	1.15	0.00
USA	0.69	(0.76, 3.15)	3.1	0.08	-0.01	n/a
West Germany	0.71	(2.18, 8.95)	4.0	0.18	2.80	0.06

Table 7 reports the final set of results on reallocation, for 1979-90. By this period, reallocation effects are small for nearly all the countries considered, even when assuming a wage differential as high as four. Reallocation accounts for more than a tenth of the growth rate for just two countries, Spain and Italy.

Table 7  
Reallocation effects 1979-90

Country	$\eta$	$d_1 < d < d_2$	$d$	$R$	$G$	$R/G$
Belgium	0.73	(1.37, 7.43)	4.0	0.03	2.00	0.02
Denmark	0.73	(1.45, 8.04)	4.0	0.11	1.70	0.06
France	0.70	(1.56, 8.74)	4.0	0.15	2.06	0.07
Italy	0.69	(1.97, 11.22)	4.0	0.21	1.75	0.12
Netherlands	0.70	(1.18, 6.53)	4.0	0.00	0.71	0.00
Norway	0.73	(1.64, 9.15)	4.0	0.12	1.99	0.06
Spain	0.78	(2.49, 14.23)	4.0	0.42	2.85	0.15
Sweden	0.73	(1.48, 8.18)	4.0	0.10	1.51	0.07
United Kingdom	0.69	(1.08, 5.87)	4.0	0.05	1.44	0.03
USA	0.67	(0.80, 4.38)	4.0	0.00	0.75	0.00
West Germany	0.70	(2.03, 11.03)	4.0	0.10	1.54	0.06

Clearly this is not the only way one could assess the importance of labour reallocation, and it is interesting to compare these results with others previously available. The notable recent work of Temin (1999) investigates post-war European growth using growth regressions.<sup>12</sup> His specification includes the initial share of agriculture in employment as an explanatory variable. The results indicate that labour reallocation in West Germany raised the growth rate by about one percentage point over 1950-75. This is somewhat larger than the effect I have calculated, though not wildly so. For instance, in terms of this paper's framework, one would need to assume a wage differential greater than seven to get a reallocation effect of one percentage point over 1950-55; higher for 1955-62.

Although the results are quite similar, it is possible that Temin's regressions do overstate the effect of labour reallocation. In a growth regression, the initial value of the employment share of agriculture may act as a proxy for other aspects of development, such as the level of total factor productivity in non-agriculture. If countries that start with a high share of workers in agriculture also have low TFP in non-agriculture, they may exhibit rapid growth through technological catch-up in non-agriculture. A growth regression could conflate this effect with that of reallocation.

Now that we have estimates of the reallocation effect for several countries, we can ask whether reallocation helps explain both the cross-country variation in growth rates, and the post-1973 growth slowdown. I start by examining the productivity slowdown (Table 8). For eleven countries, I calculate the difference between the growth rate in output per worker for 1960-73 and that for 1979-90.<sup>13</sup> Table 8 shows that, as is well

<sup>12</sup>See Dowrick and Gemmell (1991) and Paci and Pigliaru (1999) for related approaches to structural change, also based on regressions.

<sup>13</sup>This comparison seems more meaningful than one using data from 1973-79, since growth rates for

known, growth rates were dramatically lower in 1979-90 than in 1960-73 for nearly all the major economies of Western Europe. The fall in the growth rate of output per worker usually exceeds two percentage points.

I also calculate the change in the labour reallocation effect ( $\Delta R$ ) between these two periods. This allows a rough estimate of the fraction of the growth slowdown that can be attributed to the falling importance of reallocation over time ( $\Delta R/\Delta G$ ). Based on the reallocation effects previously calculated, I find that the diminishing importance of reallocation typically accounts for a tenth to a seventh of the slowdown in growth in output per worker, at most.<sup>14</sup>

Country	Growth 1960-73	Growth 1979-90	$\Delta G$	$\Delta R$	$\Delta R/\Delta G$
Belgium	4.31	2.00	-2.31	-0.10	0.04
Denmark	3.90	1.70	-2.20	-0.35	0.16
France	4.48	2.06	-2.41	-0.29	0.12
Italy	5.50	1.75	-3.74	-0.56	0.15
Netherlands	4.37	0.71	-3.66	-0.14	0.04
Norway	3.17	1.99	-1.18	-0.17	0.14
Spain	6.03	2.85	-3.18	-0.50	0.16
Sweden	3.60	1.51	-2.09	-0.26	0.12
United Kingdom	2.51	1.44	-1.07	-0.03	0.03
USA	1.74	0.75	-0.99	-0.13	0.13
West Germany	4.10	1.54	-2.56	-0.20	0.08

It might be thought that this calculation is an understatement, because the reallocation effects for 1979-90 assume a wage differential of four, which is implausibly high for this period. In practice, as noted previously, this does not make much difference. The reason is that the employment shifts of the 1980s are small, and so the reallocation effect is found to be close to zero for this period in any case, with the possible exceptions of Spain and Italy. Even if I impose equality of wages across sectors for the 1980s, so that the reallocation effect is always zero for 1979-90, I still find that changes in the importance of reallocation account for less than 20% of the growth slowdown for most countries.

Next, I explore the extent to which the direct effect of labour reallocation explains differences in growth performance across countries, rather than over time. The nine countries considered are those studied by Denison. If we think of each of their growth

the 1970s are affected by adjustment to the first oil shock.

<sup>14</sup>See also van Ark (1996, p. 93-97). He finds that changes in productivity growth within sectors account for the majority of the productivity slowdown, consistent with the results in this paper.

rates as the sum of the reallocation effect and a component not associated with reallocation, a natural approach is to calculate the variance of growth rates ( $\sigma^2$ ) and the variance of growth rates minus the reallocation effects ( $\sigma_{AR}^2$ ). The latter can be thought of as the variance that would have been observed in the absence of the reallocation effect on TFP growth.<sup>15</sup>

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Table 9  
Reallocation effects and cross-country variation

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Period	$\sigma^2$	$\sigma_{AR}^2$
1950-55	2.21	1.61
1955-60	1.62	1.17
1960-73	1.15	0.89
1973-79	0.78	0.69
1979-90	0.23	0.19

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These figures are presented in Table 9. For the period until 1973, it can be seen that the variance of growth rates is rather lower after eliminating the effect of reallocation. This implies that the differing extent of labour reallocation is a major factor in explaining differences in post-war growth performance across Western Europe. It is also interesting to note that European growth rates have steadily converged: by 1979-90 the cross-section variation is low, and reallocation is little help in explaining it.

## 7 Conclusions

This paper measures the direct contribution of structural change to growth in aggregate total factor productivity; hence the paper follows in the tradition of Kuznets (1961) and Denison (1967). Although the basic methods are well known, empirical applications are usually based on guesswork about output elasticities or the wage differential between sectors. A key innovation of this paper is to show that readily available data can be used to derive approximate bounds on the intersectoral wage differential, sometimes allowing more reliable estimates.

I have used this framework to revisit the reallocation estimates for the 1950s presented in the classic work of Denison (1967). The paper also presents new estimates of labour reallocation effects for 1960-90 for all the major economies of Western Europe, and the USA. This allows me to quantify, relatively precisely, the direct contribution of structural change to rapid growth, its role in the 1970s productivity slowdown, and

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<sup>15</sup>A more subtle counterfactual would allow for other effects of intersectoral reallocation, for instance on growth in total employment and the capital stock. These effects would clearly have further implications for the counterfactual variance of growth rates in the absence of reallocation.



its importance in explaining the wide cross-country variation in growth rates observed after 1950.

In summary, the results indicate that labour reallocation typically accounted for around a twentieth to a seventh of growth in output per worker between 1950 and 1979. In the 1950s, reallocation was particularly important for Italy and West Germany, and to a lesser extent France. After 1960, the size of the effect on the annual growth rate continued to be large for Italy, and was also important for Spain.<sup>16</sup> In these two countries, reallocation raised the annual growth rate by somewhere between a half and a full percentage point, at least until 1973.

For some countries, reallocation effects had virtually disappeared by the 1970s, and the estimated effect is small for nearly all countries for 1979-90. This implies that the falling 'TFP bonus' of structural change played some role in the post-1973 productivity slowdown. Yet the effect is not an important one. My estimates suggest that reduced scope for labour reallocation accounted for around a seventh of the decline in annual growth rates, at most. This result appears to be quite robust to alternative assumptions.

Overall, some of the effects may appear unexpectedly small. As noted in the introduction, the approach gives only a partial view of the overall contribution of structural change. First, the present analysis does not explore the 'permissive' role of structural change, traditionally quantified using shift-share analysis. Second, there are a number of mechanisms by which labour reallocation could make a greater contribution to output growth. One possibility is that returns to scale in the non-agricultural sector may be increasing, as emphasised by Kaldor (1966). It is also worth noting that gains in aggregate TFP could induce a rise in the capital stock, so the figures reported above somewhat understate the overall impact on output. The present analysis also leaves aside other general equilibrium effects, such as changes in labour force participation rates that might be associated with changing patterns of employment.

Importantly, although there are grounds to believe that the present estimates of reallocation effects are too low, the labour reallocation story already does quite well in accounting for the variation in post-war growth performance across Western Europe. Differences in the extent of structural change explain a substantial fraction of the variation in growth rates, at least until the convergence of growth rates in the mid-1970s. This suggests that future work on this topic should be careful to follow Denison (1967) and Temin (1999) in acknowledging the key role of structural change.

Finally, since this paper has extended previous methods for analysing the direct effect of labour reallocation, it potentially has wider relevance. It would be interesting to apply the same analysis to the growth of poorer countries, given the conventional

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<sup>16</sup>Due to data limitations, the paper does not examine reallocation in Spain before 1960. The agricultural employment share for Spain fell from around 47% to 40% between 1950-60; but the majority of the overall decline was concentrated in the period 1960-73.

view that rural-urban wage differentials are sometimes substantial in the developing world.

## 8 Appendix 1: The labour reallocation effect

Start with the equation for output growth:

$$\frac{\dot{Y}}{Y} = \frac{\dot{Y}_a}{Y} + p \frac{\dot{Y}_m}{Y} \quad (13)$$

Differentiating the agricultural production function, we can write the first term as:

$$\begin{aligned} \frac{\dot{Y}_a}{Y} &= \frac{\dot{A}_a}{A_a} \frac{A_a F(\cdot)}{Y} + \frac{A_a F_{KK} K}{Y} \frac{\dot{K}_a}{K} + \frac{A_a F_{LL} L}{Y} \frac{\dot{L}_a}{L} \\ &= s \frac{\dot{A}_a}{A_a} + (1 - \eta) \frac{\dot{K}_a}{K} + \phi \frac{\dot{L}_a}{L} \end{aligned} \quad (14)$$

where  $s = Y_a/Y$  is the share of agricultural output in total output.

$$\begin{aligned} p \frac{\dot{Y}_m}{Y} &= \frac{\dot{A}_m}{A_m} \frac{p A_m G(\cdot)}{Y} + \frac{p A_m G_{KK} K}{Y} \frac{\dot{K}_m}{K} + \frac{p A_m G_{LL} L}{Y} \frac{\dot{L}_m}{L} \\ &= (1 - s) \frac{\dot{A}_m}{A_m} + (1 - \eta) \frac{\dot{K}_m}{K} + \frac{w_m L}{Y} \frac{\dot{L}_m}{L} \\ &= (1 - s) \frac{\dot{A}_m}{A_m} + (1 - \eta) \frac{\dot{K}_m}{K} + d \phi \frac{\dot{L}_m}{L} \end{aligned} \quad (15)$$

where the last line uses  $w_m = dw_a$ .

Combining (13), (14) and (15) we get:

$$\frac{\dot{Y}}{Y} = s \frac{\dot{A}_a}{A_a} + (1 - s) \frac{\dot{A}_m}{A_m} + (1 - \eta) \frac{\dot{K}}{K} + \phi \frac{\dot{L}_a}{L} + d \phi \frac{\dot{L}_m}{L} \quad (16)$$

We can rewrite the last two terms as:

$$\begin{aligned} &\phi \frac{\dot{L}_a}{L} + \phi \frac{\dot{L}_m}{L} + (d - 1) \phi \frac{\dot{L}_m}{L} \\ &= \phi \frac{\dot{L}}{L} + (d - 1) \phi \frac{\dot{L}_m}{L} \\ &= \eta \frac{\dot{L}}{L} - (d - 1)(1 - a) \phi \frac{\dot{L}}{L} + (d - 1)(1 - a) \phi \frac{\dot{L}_m}{L_m} \end{aligned}$$

where the last line uses equation (4) and  $L_m = (1 - a)L$ . We can now rewrite the last line as:

$$\begin{aligned} &\eta \frac{\dot{L}}{L} + (d - 1)(1 - a) \phi \left[ \frac{\dot{L}_m}{L_m} - \frac{\dot{L}}{L} \right] \\ &= \eta \frac{\dot{L}}{L} + (d - 1)(1 - a) \phi \frac{\dot{m}}{m} \end{aligned}$$

where the last line uses  $L_m = mL$ . We can now rewrite equation (16) and so demonstrate that labour reallocation is a component of growth in aggregate total factor productivity (ie. the residual obtained after suitably weighting aggregate labour force and capital growth).

Also note that, using equation (4), the labour reallocation effect can also be expressed as:

$$\frac{(d-1)(1-a)}{1+(d-1)(1-a)} \eta \frac{\dot{m}}{m}$$

which is the form emphasised in the text.

## 9 Appendix 2: Data

For most countries, the figures for growth in output per worker are calculated using data in van Ark (1996, Appendix tables). In the van Ark data there is no figure for 1955 employment for the Netherlands, Spain and Sweden. To remedy this, I use Maddison's population data to calculate a labour force participation rate for the nearest available year (1956 for the Netherlands and Spain, and 1960 for Sweden) and also for 1950. I then use interpolation to calculate a labour force participation rate for 1955, and combine this with Maddison's population figure for 1955 to obtain an estimate of 1955 employment.

The figures for growth in output per worker for Belgium are constructed using output data from Maddison (1996) and employment data from the OECD (1961, 1968, 1994). The figures for growth in output per worker for Norway are based on an output index from Maddison (1995, Table B10-a) and employment data from the OECD (1961, 1968, 1994).

Data on agricultural output and employment shares for 1960 and onwards are again drawn from van Ark (1996). For Belgium and Norway, the agricultural employment share for 1960 is based on linear interpolation between the figures for 1955 and 1962 reported by Denison. The agricultural output share for Belgium is derived from the OECD National Accounts (various years). The output share for Norway is estimated using the Norwegian national accounts.

The figures for labour's share for 1950 and 1955 are those reported by Denison. The figures for 1960 and beyond, for all countries except Norway, have been calculated using data kindly supplied by Olivier Blanchard. The data he supplied are taken from the OECD's Business Sector Database. In terms of the variable names found in that database, the labour share is defined as  $wsse * etb / (gdpb * 1000000)$ . Note that for some countries, the figure adopted for 1960 is based on a later date. The figure for Norway is obtained from national sources, and is calculated by dividing total employee compensation by total factor income.

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