Increasing returns, Structural Change and Growth

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Preliminary

Abstract

This paper proposes a dual-sector Solow-type model where labour reallocation interacts with the presence of involuntary unemployment in non-agriculture, as a consequence of efficiency wages considerations. The urban sector features also increasing returns to scale, and the model is used to quantify the role played by externalities on aggregate TFP growth. Furthermore, the model has been calibrated under alternative assumptions on the degree of openness, and job separation rates. Results suggest increasing returns matters most in the last three decades of the century and the performance of the model significantly improves under the closed economy assumption.

Keywords: Dual models, structural change, urban employment, growth accounting.

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1. Introduction

The implications of increasing returns in dual economy models have been debated for a long time in the economic growth literature. The concept of increasing returns itself is present from the very beginning in the history of economics, since Adam Smith's famous description of a pin factory, and has often played an important role in explaining the process of development.[1]

In this paper, we provide an analysis of the role of increasing returns in a particular aspect of the process of development: the reallocation of labour from the agricultural sector (typical source of employment during the early stages) to activities more directly related to industry and services. To this end, we develop a dynamic dual model of a small open economy, where the non-agricultural sector features production externalities. The importance of increasing returns is quantified using growth accounting techniques, which allow an investigation of the different sources of aggregate TFP growth. Furthermore, many countries experiencing structural transformation were characterized by the contemporaneous emergence (or reinforcement) of unemployment in the urban sector, which failed to act as a brake to migration. The model embeds this feature also, through a detailed specification of the labour market dynamics, based on the assumption of efficiency wages in non-agriculture, as described in Shapiro and Stiglitz (1984). The effort elicitation model, in fact, permits both to endogenize the intersectoral wage differential (the main driver for labour reallocation), and to study the effect of structural transformation on involuntary unemployment.

With the aim of providing a quantitative evaluation of the claims above, the model is calibrated to Spain, a country which experienced one of the fastest labour reallocations in Europe during the last half of the past century. In the early 1940s Spain was in fact characterized by a quite high degree of backwardness relative to other European countries, a consequence of the 1936-39 Civil war, after which General Francisco Franco established a dictatorship.

It was only with the Liberalization and Stabilization Plan of 1959 that Spain embraced a more market-oriented attitude, which of course originated the first state-wide reallocation of labour towards the more productive sectors. The transition to democ-

[1] An obvious reference is Young (1928).

racy after Franco's death in 1975 further accelerated the adoption of full market economic structures, although the country had to face the inevitable turmoils and imbalances of such a comprehensive political transformation. However, by the mid 1980s Spain was a fully developed modern economy, able to enter the European Economic Community (1986).

Results from simulations suggest that the model is not able to exactly replicate the path of structural transformation actually experienced by Spain. It delivers structural change at the beginning of the transition that is too rapid and, at least in its baseline configuration, implies the unattractive outcome of reverse migration in the last quarter of the past century, when TFP growth in agriculture was higher. However, it suggests that structural transformation does account for at least half of the increase in postwar Spanish unemployment. The growth accounting exercise finds increasing returns to be more relevant in the second subperiod, accounting for about 60 percent of aggregate TFP growth in the last three decades, while in the first two aggregate TFP is attributable almost exclusively to TFP growth in non-agriculture.

However, some of the assumptions of the model in its baseline configuration may be controversial and hence have been tested. In particular, the small open economy assumption may not be innocuous, as demonstrated in Matsuyama (1992), where trade and comparative advantage dramatically change implications for structural transformation. Thus the model has also been simulated under an alternative, closed economy, assumption. Results in this case show an improvement of the fit of the model, in particular with respect to the speed of structural transformation, but the fit of the path of the relative price deteriorates significantly. Another alternative specification investigated introduces a time varying exogenous job separation rate, to account for the increase in labour market flexibility registered in Spain, as well as in many other European countries, during the 1980s. Under this alternative specification, the model is able to account for all of the increase in unemployment observed in the data, but no noticeable differences are detected with respect to structural transformation.

The remainder of the paper is organized as follows: after having set out the relation with the existing literature in section 2., section 3. describes the model and gives a brief description of the steady state; section 4. presents the alternative assumption of a closed economy, while section 5. provides the decomposition of aggregate TFP growth and discusses the resulting components. In section 6. the algorithm and the strategy for the calibration of relevant parameters are described, while sections 7. and 8. look at results both in terms of the dynamics implied by the model (under its baseline and alternative assumptions) and in terms of growth accounting. Finally, section 9. concludes.

2. Relation to existing literature

In the modern economic literature, one of the most influential contributions on the importance of increasing returns in structural transformation episodes comes from Kaldor (1966), where the existence of increasing returns to scale in the secondary sector, "*causes productivity to increase in response to, or as a by-product of, the increase in total output*".[2] In his paper, Kaldor finds that the main cause of the slow postwar growth rate of the United Kingdom was its *prematurely reached* economic maturity, expressed in terms of broadly equal levels of income per head across sectors. The basic idea being that fast growth rates in the overall economy are driven by fast growth rates in the secondary sector (often coinciding with the manufacturing one), which in turn are associated with fast employment growth rates in that sector. The peculiarity of the increase in employment is that it is attributed to an abundant supply of labour from people migrating from the rural sector to the manufacturing (and most productive) one, following an argument already made by Lewis (1954) and Kindleberger (1967). The transition process would end when intersectoral productivity gaps are filled, as a consequence of labour accumulation in manufacturing and a corresponding reduction in agriculture.

That may partly explain what happened in postwar Europe, when a range of countries faced exceptionally high growth rates with considerable migration from rural to urban areas (a period often referred to as Europe's "Golden Age" of Growth). Thus the model of this paper can be thought of as embedding the main features of Kaldor's hypothesis, as the non-agricultural sector features increasing returns, which amplify productivity improvements, while agriculture is treated as a diminishing returns sector (due to the presence of land as a fixed factor). In the simulation, structural change is

[2] Kaldor (1966, p.8).

triggered by an exogenous increase in sectoral TFPs, and ceases to exist when incentives to migration are exhausted. In this latter sense, the theory presented here follows the Lewis (1954) idea that productivity improvements in the secondary sector attract workers out of agriculture and hence generate labour reallocation. A more recent neoclassical treatment in the same vein is provided by Hansen and Prescott (2002), where the transition from a Malthusian traditional economy to a modern Solow economy is triggered by increases in TFP of the Solow technology.[3]

Harris and Todaro (1970) provide the first and most famous formalization of the relation between structural transformation and the labour markets, and their seminal contribution triggered a large amount of literature in the field. The main intuition is that the migration decision involves comparison of expected rather than actual wages, and workers in agriculture continue to migrate, even in the presence of unemployment, until expected wages are equalized across sectors. As in Lewis (1954), Harris and Todaro (1970) also maintain the assumption of a still exogenous intersectoral wage differential, which results, in their case from a urban minimum wage set above the market clearing level. Several subsequent studies have provided alternative explanations for the endogenous emergence of a wage differential.[4] The one adopted in this paper focuses on a urban labour market characterized by efficiency wages as in Shapiro and Stiglitz (1984), where firms are forced to set wages above the market clearing level to deter workers from shirking. The closer reference in this sense is Moene (1988), which uses the Shapiro and Stiglitz (1984) efficiency wages model to generate a wage differential in a two sector economy, on the grounds that "*shirking is an even more serious problem in LDCs than it is in most developed countries*".[5] Consequently, in this framework the key aspect for the migration decision is the difference in expected lifetime utilities of living

[3]There is an alternative view, which finds in improvements in agriculture the main determinant of intersectoral labour reallocation, as a consequence of the lower income elasticity of demand peculiar to agricultural products (Engel's law). Example of studies in this area include Murphy et al. (1989), Matsuyama (1992), Caselli and Coleman (2001) as well as a sequence of papers by Douglas Gollin, Stephen Parente and Richard Rogerson (Gollin et al., 2002, 2004, 2007). The general question of the role of agriculture in development is surveyed in Gollin (2010). The alternative closed economy specification of the model of this paper does introduce some of its key features; however a better reference is (Monteforte, 2012), which explicitly considers the quantitative implications of the two alternative views into a single model of structural transformation, along the lines of an argument already made in Alvarez-Cuadrado and Poschke (2011).

[4]Among the others: land rents, adverse selection problems, bonus schemes, investments in additional education or training. Some of these are reviewed in Temple (2005).

[5]Moene (1988, p.389).

in agriculture and in the city (either employed or unemployed) rather than the difference in expected wages. However, Moene (1988) does not take a dynamic approach, restricting his analysis to steady-states considerations.

On the other hand, Kimball (1994) studies the out-of-equilibrium properties of the Shapiro and Stiglitz (1984) effort-elicitation model, but the analysis is more from a real business cycle perspective and looks at how an efficiency-wage labour market reacts to shocks, and at their propagation mechanisms. Furthermore, it shows that this specification of the labour market can generate a macroeconomic labour supply elasticity higher than its microeconomic counterpart, although the addition is quite small. This limit could be overcome if efficiency wages are interpreted in the context of a dual labour market, as shown in Kimball (1989), where *un*employment is reinterpreted as *under*employment in a low-productivity sector, therefore decreasing the share of employed workers in the high-productivity sector, which is the key variable for a higher macroeconomic labour supply elasticity. The model of this paper departs also from this reinterpretation in that it features both a dual labour market and unemployment, and takes a long-run growth perspective, adding increasing returns in one of the two sectors.

Finally, the strategy used to evaluate the importance of increasing returns in structural transformation is based on quantifying their contribution to aggregate TFP growth. To this aim, firstly, the model has been simulated varying the assumption on the degree of increasing returns from a baseline constant returns case, and, secondly, a new decomposition of aggregate TFP growth was applied, isolating the percentage contributions of increasing returns. From this perspective, this paper is also related to a third stream of literature, that on growth accounting in general surveyed in Barro (1999) and Barro and Sala-i-Martin (2004), but more in particular to that part of the literature which has quantified the weight of structural transformation in fast growth episodes.[6]

3. The model

[6]The closest examples, mainly related to the European "Golden Age", being Temple (2001), Temin (2002), Temple and Woessmann (2006) and Alvarez-Cuadrado and Pintea (2009).

3.1. Overall economy

This section will describe the model, and how the dynamic equations used in the calibration have been derived.

The focus is initially on a small open economy, formed by two sectors (agricultural, denoted with subscript a and non-agricultural, m), in which both goods can be traded.[7] The agricultural good can only be consumed, while goods from non-agriculture can either be consumed or invested in physical capital K_m. The urban good is chosen as numeraire and the relative price of the agricultural good is denoted by p_a. The economy is closed to international flows of capital and labour. While workers can work in either sector, and are freely mobile across them, physical capital is specific to the urban sector. Similarly, land is a specific factor of production in agriculture, whose total amount is fixed over time and normalized to 1 by choice of units.

The total labour force is grouped in a continuum of households and the number of workers in the urban sector is denoted by L_c. Since the main objective of the paper is the study of the properties of structural change, which by definition is a transitional process, for simplicity there is no labour force or TFP growth in the steady state. A model with an asymptotic balanced growth path will be developed in (Monteforte et al., 2012).

The overall economy's level of nominal output can thus be written as the sum of the value of output in the two sectors:

$$Y = p_a Y_a + Y_m \tag{1}$$

where Y_a and Y_m denote real output in the agricultural and manufacturing sector respectively.

The agricultural sector is characterized by a profit-maximizing representative firm, which uses a Cobb-Douglas technology with constant returns to scale and two factors of production: land and labour. Under these assumptions we can express the agricultural sector's production function as:

$$Y_a = A_a R^{1-\alpha} L_a^{\alpha}$$

[7] As common in this literature, agriculture will sometimes be referred to as the traditional sector, while non-agriculture will be also called urban or manufacturing.

where $R = 1$ is the stock of land available, L_a the agricultural sector's labour force, and A_a is agricultural TFP.

In the non-agricultural sector the focus is again on a profit-maximizing representative firm, whose production function is slightly more complicated, in that it features also the presence of increasing returns, in accordance with Kaldor's hypothesis.[8] Factors of production are (sector specific) capital and labour, but now each firm's output is assumed to be potentially dependent also on the level of output of the sector as a whole, with each firm small enough to avoid influencing it autonomously. This extra term may capture some externality such as agglomeration effects. So, the production function of the $j-th$ representative firm in the non-agricultural sector will look like:

$$Y_{mj} = A_m K_{mj}^{1-\mu} L_{mj}^{\mu} Y_m^{\frac{\phi}{1+\phi}}$$

where the $j-th$ firm's level of output is denoted by Y_{mj}, employing capital K_{mj} (with output elasticity $1-\mu$), and labour L_{mj}, while A_m is the non-agriculture sector's TFP parameter (the same across firms), Y_m is output and ϕ captures the extent of increasing returns.

Aggregating over all firms, this type of specification leads to a production function in the non-agricultural sector as a whole characterized by increasing returns in the following way:

$$Y_m = (A_m K_m^{1-\mu} L_m^{\mu})^{1+\phi}.$$

We can return to the standard constant returns case just by imposing $\phi = 0$.

At the firm level, optimality conditions require capital to be employed at every point in time until its marginal product equates to the rental rates:

$$r + \delta = (1-\mu)\frac{Y_{mj}}{K_{mj}} = (1-\mu)\frac{Y_m}{K_m} \tag{2}$$

with r and δ denoting respectively the interest rate and the depreciation rate paid on capital holdings. The last equality follows from noting that in equilibrium all firms will choose the same capital-output ratio.

[8]The way in which increasing returns are introduced follows the approach provided in Graham and Temple (2006), and the model as a whole can be interpreted in the tradition of the variable-returns-to-scale models discussed there.

Income is shared within households, and the part of it which is not consumed is invested in capital assets, thus we can write:

$$\dot{K_m} = s(p_a Y_a + Y_m) - \delta K_m \tag{3}$$

where s is the exogenous saving rate, and δ is the depreciation rate.

The labour market has a more complicated and asymmetric structure. In the agricultural sector, it is competitive and workers are assumed to be always employed. While in the city, the wage setting mechanism is based on the Shapiro and Stiglitz (1984) efficiency wage hypothesis, which will be explained in detail in the next subsection. Hence the modern sector features involuntary unemployment.

3.2. Labour markets

To describe the behaviour of workers and firms in the urban labour market, we will draw on the dynamic version of the famous Shapiro and Stiglitz (1984) model as described in Kimball (1994).

In this framework, the main starting hypothesis is that, unlike the other forms of factor of production, workers can choose their level of effort, which is difficult and costly for firms to monitor. In other words, workers are seen as "rational cheaters", and to induce them to put the required effort in their job, they have to be either "motivated" by higher wages, or "threatened" by a greater penalty if caught shirking (higher unemployment, which results in a lower probability of finding a new job).

Therefore, a representative worker's behaviour is determined by comparison of his expected lifetime utility when employed and not shirking, with respect to the same lifetime utility in the case of being a shirking worker. Of course, there is some positive probability of being caught while shirking q, so that we can express the two expected lifetime utilities in the standard "asset equation" format:

$$rW = w_m + \lambda(U - W) + \dot{W} \tag{4}$$

$$rW_s = w_m + g + (\lambda + q)(U - W_s) + \dot{W}_s \tag{5}$$

The present discounted value of being employed in the city (W) is equal to the "flow benefit” (w_m, real wage earned in the city) plus the expected capital loss of being fired at some point, represented by the exogenous job separation rate (λ) times the difference between the utility of being unemployed and that of being employed ($U - W$), plus the rate of change of W, since we will be considering out-of-equilibrium dynamics. As for the asset value of being employed of a shirking worker (W_s), the same basic structure applies, but we have to add also the monetary gain of saving working effort (g), which is counterbalanced by a higher probability of being fired ($\lambda + q$).

If a worker is unemployed, the present discounted value (U) of being in that condition will be equal to unemployment benefits (assumed proportional to the urban wage, with replacement ratio η), plus the expected capital gain of getting a job, represented by the job-acquisition rate e times the amount of additional utility acquired by becoming employed ($W - U$), plus the rate of change in U:

$$rU = \eta w_m + e(W - U) + \dot{U}. \tag{6}$$

Workers will not shirk until $W = W_s$, so if we let the no-shirking condition hold at all t, it will follow that $\dot{W} = \dot{W}_s$ for all t. Using those two equalities with (4) and (5) we can say that:

$$\begin{aligned} W &= U + \frac{g}{q} \\ &= U + X. \end{aligned} \tag{7}$$

As Kimball (1994) says: “To keep a worker from shirking at any given instant, the benefit per unit time from shirking must be less than the cost per unit time, which is the probability of detection times the cost of job loss”.[9] We assume g and q are constant, so that from (7) follows:

$$\dot{W} = \dot{U}, \qquad \forall t. \tag{8}$$

Using (6), (7) and (8), we can express the urban wage as:

$$w_m = (r + \lambda + e)\frac{X}{1 - \eta} \tag{9}$$

[9] With our notation: $g \leq q(W - U)$.

The instantaneous employment flow in the city is: $\dot{L_m} = eL_u - \lambda L_m$, and since the population in the city is made up by employed and unemployed workers ($L_c = L_m + L_u$), we can express the probability of getting a new job as: $e = \frac{\dot{L_m}+\lambda L_m}{L_c - L_m}$. Using this latter equation together with (9) and rearranging terms, yields the dynamic version of the Shapiro and Stiglitz (1984) no-shirking condition:

$$(1-\eta)w_m = \left(r + \lambda + \frac{\dot{L_m} + \lambda L_m}{L_c - L_m}\right) X \tag{10}$$

which implicitly defines the evolution of employment in the city, L_m, in terms of three endogenous variables, r, w_m and L_c.

As Kimball (1994) notes, condition (10) implies that employment has a lagged response to demand conditions, precisely because of the substitutability between unemployment and monitoring characteristic of the efficiency wages hypothesis. When non-agriculture TFP increases, in fact, firms will hire workers more slowly than it would be implied in a perfectly competitive labour market, "*since the motivation of workers who see so many help-wanted ads around them will be impaired unless they get extra-high wages*".[10] The relation between unemployment and workers incentives not to shirk will be made clear in more detail later, when we will overview the steady-states properties of the model.

On the demand side of the labour market, firms will set wages to be equal to the marginal product of labour at all times on the assumption that the representative firm always has a positive gross hiring rate.[11] So $w_m = \frac{\partial Y_m}{\partial L_m} = \mu \frac{Y_m}{L_m}$. Following this assumption, and substituting all the relevant values in (4), it is possible to get the final equations for the evolution of the asset value of being employed in the non-agricultural sector and an equation for the change in urban employment:

$$\dot{W} = rW - \mu \frac{Y_m}{L_m} + \lambda X \tag{11}$$

$$\dot{L_m} = \left[(1-\eta)\frac{\mu Y_m}{L_m X} - r\right](L_c - L_m) - bL_c \tag{12}$$

On the other hand, the agricultural sector is assumed to have a simpler and standard

[10] Kimball (1994, p.1051). Conversely, when there is a reduction in productivity, firms will be reluctant to fire workers, because they can keep them more motivated, due to the increased penalty from shirking.

[11] See Kimball (1994) for more details on this.

structure in which the wage equals the marginal product of labour: $w_a = \alpha\frac{Y_a}{L_a}$. This is a reasonable assumption if we think about an agricultural sector in which it is either easier to monitor workers behaviour and fire them in case of shirking (in an efficiency wages approach).

3.3. Migration and the relative price

To close the model we need one more equation, describing how workers decide the sector of employment.

A natural assumption for the workers' migration decision is that they will decide to switch sector only if it pays them to do so. Since workers are forward looking and, in the case of migration to the city, have to spend some time unemployed, the relevant decision is characterized by comparison of the expected lifetime utility of working in agriculture (A) or being unemployed in the urban sector (U), ie:

$$rA = rU \tag{13}$$

Given the assumption of a perfectly competitive labour market in agriculture, the asset value of being in that sector is simply $rA = w_a + \dot{A}$, so substituting in relevant expressions for both states, the migration condition can be rewritten as:

$$w_a = w_m - (r + \lambda)X \tag{14}$$

where the fact that (13) holds also in rates of change has been used.

Finally, given the baseline assumption of a small open economy the behaviour of the relative price is exogenously determined at the world level, and therefore we need to introduce an equation pinning down the path of the relative price from available data. This is explained in more detail in the calibration section, but it can already be said that the price follows a downward sloping path.

3.4. Static analysis

The model sketched in the last section can thus be summarized with three differential and two static equations that will be used to analyze its transitional dynamics. In particular, the model will be used to study the reallocation of labour between sectors when the economy moves from an initial point (defined by exogenous starting values) and evolves over time to its final steady-state. Moreover, we will also look at how the dynamic process is affected by assuming various degrees of increasing returns (different values of ϕ).

The transitional dynamics are described by the following set of equations:
jump variables:

$$\dot{W} = rW - \mu \frac{Y_m}{L_m} + \lambda X \tag{15}$$

state and exogenous variables:

$$\dot{K_m} = s(Y_m + p_a Y_a) - \delta K_m \tag{16}$$

$$\dot{L_m} = \left[(1-\eta) \frac{\mu Y_m}{L_m X} - r \right] (L_c - L_m) - \lambda L_c \tag{17}$$

static equations, satisfied at all points in time:

$$p_a \alpha \frac{Y_a}{hL_a} = \mu \frac{Y_m}{hL_m} - (r+\lambda) X \tag{18}$$

$$r + \delta = (1-\mu) \frac{Y_m}{K_m} \tag{19}$$

But before turning to the dynamic analysis, it is useful to understand what happens in the steady state. Of course, when the economy is in the steady state all the left hand side terms in the system (15)-(17) are set to zero, and there is a unique non-trivial solution to it.[12] In the non-agricultural sector the equilibrium in the labour market will be described as in the standard Shapiro and Stiglitz (1984) model: firms will offer a wage high enough to deter workers from shirking. Since in equilibrium flows into and out of unemployment should be equal, we can express the sum of job acquisition and separation rates as a function of the separation and unemployment rates in the economy, weighted by the share of total population living in the city.

The standard no-shirking condition for the wage in the urban sector follows, which, in an efficiency wage framework, has the function of a labour supply equation in a stan-

[12] It was not possible to establish in a general way saddle-stability around the steady state, but, at least for the parameter choice adopted for the calibration, numerical calculations of the eigenvalues of the Jacobian matrix, resulting from a first-order linear approximation around the steady state, indicate saddle-path stability.

dard model of the labour market:

$$w_m = \left[r + (1-a)\frac{\lambda}{u_n} \right] \frac{X}{1-\eta} \tag{20}$$

where $u_n = L_u/L$ is the overall economy's unemployment rate, $a = L_a/L$ is the agriculture share of the total labour force, and therefore $(1-a) = L_c/L$ constitutes its urban counterpart. The equation above, in the spirit of the efficiency wages literature, is useful for stressing that monitoring workers and unemployment are substitutes: if all firms set wages higher than the market implied level, workers will have an incentive to shirk unless there is a higher level of unemployment in the economy, so that the penalty associated with the job loss increases. Symmetrically, the lower the unemployment rate, the higher the wage implied by the no-shirking condition to induce workers not to shirk. A final consideration about the wage setting condition: in this model the unemployment rate is an endogenous variable and depends not only on the behaviour of agents within the city, but also on migration from the agricultural sector. Therefore equation (20) above can alternatively be expressed as an increasing function of the population in the city as in Moene (1988).

As for the other variables, capital will reach a point at which it is accumulated just to cover depreciation costs, and there will be no growth in the steady-state, since neither sectoral TFP parameters, nor labour force are assumed to grow unbounded at constant rates.[13] The agricultural sector, as explained above, will see wages adjusting to the marginal productivity of labour in that sector at any time, so that will also be the case in equilibrium. As for the relative size of the two sectors considered, they will show a transition process as described in Harris and Todaro (1970), and migration will take place until the expected discounted value of being employed in the agricultural sector will be equal to that of being unemployed (but with a chance of getting a better paid job) in the city. This implies that there will be a wage differential in equilibrium.

[13] Actually, in the calibration exercise transition will be induced by an exogenous change in sectoral TFP as well as in other time-varying parameters (namely the relative price p_a, and the replacement ratio η), but in this paper their path is assumed to be bounded and is fitted to available data.

4. Alternative assumption: closed economy

In the baseline case, a small open economy has been assumed, with the relative price of the agricultural good determined by world markets. However, as suggested in Matsuyama (1992), different consequences might arise depending on the assumptions on openness. In the calibration section we will investigate if this is confirmed also for the case of the present model, however to this extent we need to specify how the price is endogenously determined in the case of a closed economy.

First of all, if before we abstracted from an exact specification of the representative household's preferences on consumption allocations across the two goods, this is no longer possible when assuming a closed economy. We assume preferences to take the following Stone-Geary form:

$$B(c_a - \gamma_a)^{(1-\lambda_p)}(c_m + \gamma_m)^{\lambda_p} \tag{21}$$

where $B \equiv \lambda_p^{-\lambda_p}(1-\lambda_p)^{-(1-\lambda_p)}$ is a constant (useful for simplifications), γ_a denotes the subsistence level of consumption of the agricultural good (c_a), while γ_m captures an exogenous endowment of urban good (whose consumption is denoted by c_m). This specification of preferences, which follows Alvarez-Cuadrado and Poschke (2011), allows the model to be consistent with the evidence of Engel's law (income elasticity of the agriculture goods lower than unity) and at the same time preserves analytical tractability. In the limit, budget shares are constant (and equal to respective exponents in the utility function) and independent from the level of income.

Since the saving decision is still exogenously determined, the individual budget constraint can be written as:

$$p_a c_a + c_m = (1-s)(Y_m + p_a Y_a) \tag{22}$$

which implies the following (Hicksian) demand functions:

$$c_a = (1-\lambda_p)p_a^{-\lambda_p}\bar{c} + \gamma_a \tag{23}$$

$$c_m = \lambda_p p_a^{(1-\lambda_p)}\bar{c} - \gamma_m \tag{24}$$

where $\bar{c}$ denotes the composite consumption good. Finally, assuming that agricultural production clears the market at the prevailing price ($c_a = Y_a$), and combining (22) with (23) and (24), yields the equation for the optimal allocation of consumption pinning down the relative price:

$$\frac{\lambda_p}{1-\lambda_p} = \frac{(1-s)Y_m - sp_aY_a + \gamma_m}{p_a(Y_a - \gamma_a)}. \tag{25}$$

5. Growth accounting and increasing returns

This section describes how to decompose the aggregate TFP growth rate in three components: a technological progress effect, a pure labour reallocation effect and an IRS effect. This is a way to measure the contribution of each component to overall TFP growth and assess their relative importance, an experiment carried out in section 8., assuming different degrees of increasing returns to scale.

The decomposition initially goes along the lines of Temple (2001), and we refer to the appendix for the details. Here we will stress the main points in deriving the three components and the main differences from the standard growth accounting exercise.

First, we define as real output growth, the difference between the growth rates of nominal output and the (weighted) relative price. In other words, writing (1) in growth rates and rearranging:

$$\frac{\dot{Y}_{real}}{Y_{real}} = \frac{\dot{Y}}{Y} - s_a\frac{\dot{p}_a}{p_a} = (1-s_a)\frac{\dot{Y}_m}{Y_m} + s_a\frac{\dot{Y}_a}{Y_a} \tag{26}$$

where s_a denotes the agricultural sector share of output ($s_a = \frac{p_aY_a}{Y}$, hence, $(1-s_a)$, is the urban sector output share). From inspection of the last equality in (26), it is thus evident that our definition of real output growth can be reinterpreted as a Divisia-aggregation of real output growth in each sector with weights corresponding to the relevant shares in nominal output.

It is then useful to define the aggregate labour income share as a function of the national unemployment rate (u_n), wage differential ($d = w_m/w_a$), the agricultural share in total labour force (a), and another variable ($\varphi = \frac{w_aL}{Y}$) which is roughly equal to the share of labour in national income:

$$\begin{aligned}\omega &= \frac{w_a L_a + w_m L_m}{Y} \\ &= \varphi[a + d(1 - a - u_n)] \qquad (27)\end{aligned}$$

Using (27), calculations shown in the appendix decompose the output growth rate in its different components. If a researcher calculates aggregate TFP growth using data on the overall employment in the economy, it turns out that the standard Solow residual can be written as:

$$\begin{aligned}\frac{T\dot{F}P}{TFP} &= (1 - s_a)\frac{\dot{A}_m}{A_m} + s_a \frac{\dot{A}_a}{A_a} \qquad (28)\\ &+ \frac{\eta(d-1)(1-a-u_n)}{a + d(1-a-u_n)}\frac{\dot{m}_e}{m_e} + \qquad (29)\\ &+ \phi(1 - s_a)\frac{\dot{A}_m}{A_m} + \\ &+ \phi(1 - \omega - \nu)\frac{\dot{K}_m}{K_m} + \\ &+ \phi\frac{\omega(d-1)(1-a-u_n)}{a + d(1-a-u_n)}\frac{\dot{L}_m}{L_m} \qquad (30)\end{aligned}$$

where ν is land's share of total income (and hence, $1 - \omega - \nu$ is the capital share) and $m_e = L_m/L_e$ is urban employment relative to total employment ($L_e = L_a + L_m$).

In this decomposition (28) represents the direct contribution to TFP growth of sectoral technologies , while (29) is the direct effect of labour reallocation (in other words, the effect purely due to the fact that workers have moved from a sector with lower marginal productivity to a sector with a higher one). This is the modified version of the reallocation effect calculation in Temple (2001) and in Temple and Woessmann (2006). In this case, this term takes also into account the fact that not all the population in the urban area is employed: in fact, unemployment enters into its coefficient and the relevant figure is the growth rate of urban employment expressed as a share of the overall employment in the economy and not of the whole labour force (which, in standard cases, is assumed to be fully employed in both sectors). The third component, (30), is represented by the sum of the three terms that depend on ϕ. It measures the effect that the presence of increasing returns to scale in the urban sector will have on aggregate

TFP growth. Of course, agglomeration effects amplify the effects of changes in inputs, so it should not be surprising that technology growth is amplified (first term in 30), as well as accumulation of capital (second term) and labour (third term).

6. Calibration

In this section we will turn to the analysis of the adjustment process towards the steady state, when some parameters, in particular sectoral TFP levels, follow the exogenous path displayed in the data.[14] The model is (loosely) calibrated to the postwar Spanish structural transformation (1950-2005), and its performance against observed data will be discussed. We will then focus on how alternative assumptions on openness and the labour market will modify the dynamics of the model. Finally, it will be analyzed how the transitional dynamics change with respect to different assumptions on the degree of increasing returns, in order to shed some light on the importance of increasing returns for TFP growth, as suggested in the seminal work by Kaldor (1966). Before discussing the results, however, it is useful to briefly describe the numerical procedure used and how parameter values have been calibrated to the post-war Spanish economy.

6.1. Numerical procedure

The model described in the previous section is a forward-looking model. And, as often the case for this kind of model, it gives rise to a system of non-linear differential equations whose solution can only be computed by means of numerical methods. In this study, the numerical procedure used for the calibration is the one recommended in Trimborn et al. (2008), a relaxation procedure. We refer to the just mentioned paper for the technical details about the algorithm. Here we will just briefly describe the main idea of how the algorithm works, what are its advantages with respect to other methods, and why it is relevant to our analysis.

The relaxation algorithm gives a fairly good and efficient numerical approximation even to high dimensional systems of differential equations, or to models that give rise

[14] As will become clear from the detailed discussion in section 6.2., the simulation starts from the initial conditions implied by the starting values of relevant time-varying parameters, and terminates when the final steady-state is reached, which is assumed to be close to the values observed in year 2005.

to saddle-point stable manifolds (as is the case here). It starts with a loose trial guess for the path implied by the system of differential equations and then, at each step, updates the solution using a multidimensional error function in a Newton-type iteration, without jeopardizing the boundary conditions. The version programmed by Trimborn et al. (2008) is also user friendly, in the sense that it requires the introduction of the system of differential equations "as is", without any prior manipulation. Together with the system, n_1 boundary conditions at the starting point are required (corresponding to the number of state variables), as well as n_2 final boundary conditions (corresponding to the number of control variables) and n_3 static equations that hold at any point in time (typically equilibrium conditions or feasibility constraints). If we choose J mesh points to discretize the time path of the solution, then the algorithm approximates the slope between each mesh point with $J-1$ systems of nonlinear equations of dimension n_1+n_2 and, after adding the boundary conditions and the static equations, ends up with a system of differential equation of dimension $J \times N$ ($N = n_1+n_2+n_3$), whose peculiarity relies on the structure of the corresponding Jacobian matrix used to calculate its roots, and therefore to solve the original system.[15] One of the important features of this procedure is that it allows for a very high degree of accuracy in the approximation because the number of mesh points can be increased without high costs in terms of computational time. Lastly, another important feature is that by a simple transformation the algorithm allows also for the study of infinite horizon problems (as here), mapping the interval $[0, \infty]$ to $[0, 1]$.

6.2. Parameter assumptions

The time unit assumed is a month. Most of the parameters have been calibrated using Spanish data available from the EU-KLEMS database (O'Mahony and Timmer, 2009), supplemented in some cases by other sources like the CEP-OECD dataset (Nickell, 2006) and Prados de la Escosura (2003), and can be roughly divided in two groups: those assumed to be fixed over the entire time period, and those which change exogenously to reflect paths displayed in the data. The former are summarized in table 1 below, the latter in table 2.

Given the assumption of Cobb-Douglas production functions in both sectors and

[15] See the appendix in Trimborn et al. (2008) for more details.

Table 1: Calibrated parameter values - baseline case

	Parameter	Value
Agr labour income share	α	0.7
Urban labour income share	μ	0.66
Saving rate (annualized)	s	0.21
Depreciation rate (annualized)	δ	0.06
Increasing returns parameter	ϕ	0
Job destruction rate (annualized)	λ	0.2
Value of job loss	X	23.21

the fact that factors are paid their marginal products, output elasticities with respect to factors of production coincide with respective income shares. Thus, μ corresponds to the average labour income share in Spanish non-agriculture between 1970 and 2005 as observed in the EU-KLEMS database, which indicates furthermore stability over time, justifying the adoption of Cobb-Douglas technologies. Correspondingly, α has been set to the average Spanish labour income share in agriculture, but in this case the main reference is Garrido Ruiz (2005), since it provides more accurate figures which consider explicitly information on self-employed farm workers (a major source of employment in agriculture, particularly during the early years of the reference period).[16]

The assumption on the depreciation rate follows those made in EU-KLEMS, with special reference to infrastructure and machinery, while the saving rate corresponds to the average share of investment expenditure over the entire reference period as given in Prados de la Escosura (2003). Performing a growth accounting exercise for non-agriculture using the Spanish EU-KLEMS data with the assumption of even a low degree of increasing returns ($\phi = 0.05$), yields the unrealistic result of constant TFP for Spain between 1970 and 2005. Thus we conclude that Spanish data do not support any degree of increasing returns, and the simulation in the baseline case assumes constant returns to scale (ie, $\phi = 0$). The job separation rate reflects the Spanish average exit rates from employment computed by Petrongolo and Pissarides (2008). Finally, the

[16]A more detailed discussion on the inaccuracies arising from the difficult measurement of self-employment income in agriculture is provided in (Monteforte, 2012).

value of the shirking job loss parameter X, as defined in (7), was calibrated to match the unemployment rate in 2005, and for computational reasons has been kept constant over time, although it would be sensible to think it was higher in the early years during the dictatorship and gradually lowered as the transition to democracy was completed, given that the rigid employment system under General Franco may have guaranteed high gains from shirking with a low probability of being caught and fired.

The set of parameters assumed to evolve over time to match particular features of the Spanish economy include the sectoral TFP parameters A_a and A_m, as well as the relative price p_a, the replacement ratio η, and the labour force L (ℓ in logs). For all of them the dynamics are governed by the following logistic equation, which fits well with the data:

$$\dot{z} = \psi_z(z - \underline{z})(\overline{z} - z) \tag{31}$$

where $z = A_a, A_m, p_a, \eta, \ell$ denotes the actual parameter considered, which varies between bounds $\underline{z}$ and $\overline{z}$ at speed ψ_z.[17] Table 2 reports initial and final values for each variable; exact parameter values are not directly relevant for interpreting the simulation results, and thus are not reported.[18]

Having chosen parameter values of (31) in the way that will be described below in more detail, the algorithm simulates the behaviour of an economy starting at the initial values summarized in table 2. However, it is worth noting that, as the value of the job loss X was chosen to match the unemployment rate in year 2005, the starting value of the relative price p_a was chosen to match the agricultural employment share at the end of the reference period.[19]

Now we will describe in detail how parameters in (31) have been set. In the case of the first three variables, parameters are estimated from available data. In particular, time series on sectoral TFP have been retrieved through sectoral growth accounting using data from EU-KLEMS, and the choice of the form of the differential equation is justified by the clear S-shaped pattern displayed in the data in both cases.[20] A possible

[17]The functional form in 31 will be discussed in more detail in the appendix to this paper.

[18]All parameters increase over time with exception of p_a, which instead varies between $\overline{p_a}$ and $\underline{p_a}$ at (negative) speed ψ_{p_a}.

[19]The implied assumption being that the steady state values of the variables matched when calibrating X and p_a do not differ much from the values observed in year 2005. Although controversial, this assumption is acceptable provided that most of (actually, nearly all) the adjustment takes place before, which is indeed the case here.

[20]This is the case in particular for agriculture, where it has been possible to estimate the relation using

interpretation of the assumptions on TFP dynamics could be, along the lines of Benhabib and Spiegel (1994), that it takes time for technologies to catch up with the world frontier. This could be due, for example, to the time needed to develop the skills required to adapt new ideas in different productive frameworks, but also to various other causes: with particular reference to manufacturing, it could be the time to acquire relevant patents, or to build new machines. Another plausible explanation could be that historical events - naturally wartime and autarky for Spain - led the economy to be a long way below the world level of technology.

Similarly, parameter values for the relative price have been estimated using nonlinear least squares based on data from Prados de la Escosura (2003).[21] In this case however, since, as mentioned above, the starting value was backed out to match the agricultural employment share in 2005, bounds have been opportunely rescaled to be consistent with those estimated from the data.

As for labour force ℓ, just the speed parameter ψ_ℓ was estimated, since bounds were imposed to match the total increase in the Spanish labour force observed over the entire period.[22]

Finally, the dynamics of the replacement ratio η are described again by (31). In this case the calibration approach follows a different strategy, in that the speed of adjustment is obtained in order to match the extent of unemployment benefits in the year of their introduction (1961). However, the lower bound has been set to 0.1, implying a certain (low) degree of unemployment benefits even before their formal introduction, on the grounds that the dictatorship provided alternative forms of insurance against the risk of unemployment.[23] To summarize, figure 1 below represents the behaviour of the time varying parameters against their observed values, to allow a clearer evaluation

directly the EU-KLEMS data although it covers just the period 1970-2005 (data for years prior to 1970 have been inputed fitting the logistic equation). In the urban sector, instead, the pattern although still present is less pronounced, thus the EU-KLEMS data have been supplemented by data for the first two decades calculated using Domar aggregation on the basis of the aggregate TFP estimates provided in Prados de la Escosura and Rosés (2009).

[21] The appendix provides a more detailed explanation of the procedure used for estimation of parameters in (31).

[22] Data on Spanish labour force come from the OECD labour force statistics.

[23] Malo De Molina and Serrano (1979) (as cited by Bentolila and Blanchard, 1990) depict the labour market as characterized by flexible wages, but rigid employment. A more detailed discussion of the Spanish labour market during the transition from dictatorship to democracy is provided in (Monteforte, 2012), where a model with search frictions permits to characterize the labour market along a greater number of dimensions, including unionization and firms' entry costs.

Table 2: Initial and final conditions for time varying parameters - baseline case

	Variable	**Value**
Agricultural TFP in 1950	A_a	1
Agricultural TFP in 2005		5.13
Urban TFP in 1950	A_m	1
Urban TFP in 2005		2.49
Relative price of agr good in 1950	p_a	4.76
Relative price of agr good in 2005		2.13
Replacement ratio in 1950	η	0.1
Replacement ratio in 2005		0.76
Labour force in 1950	L	0.55
Labour force in 2005		1

of the relevant assumptions.

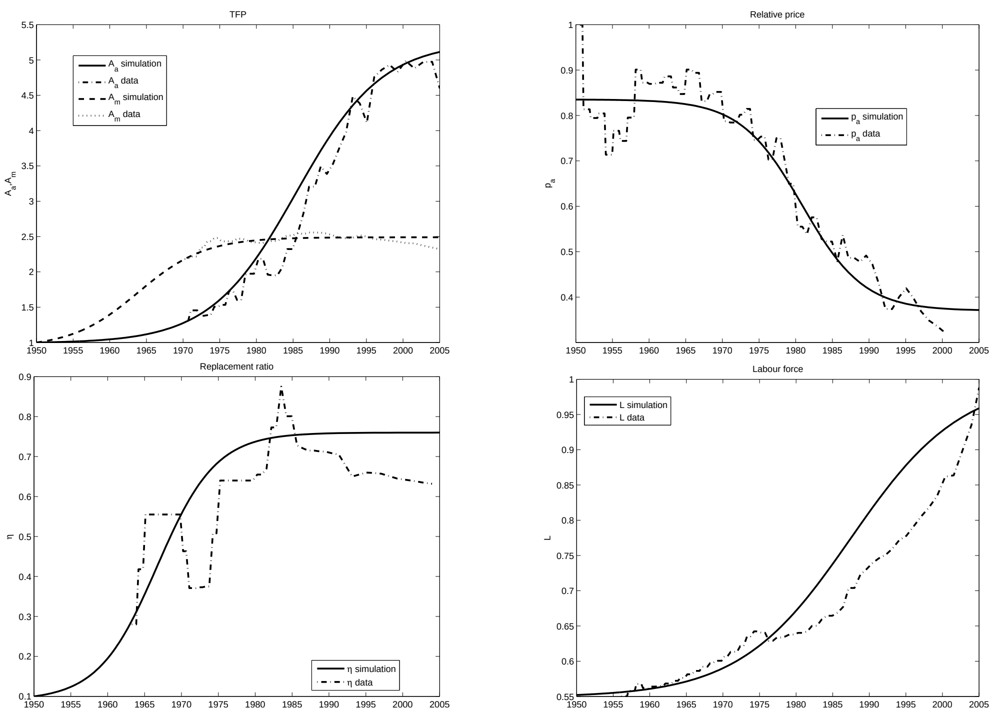

Figure 1: Time varying parameters paths

7. Main results

The transition can be characterized by looking at two main subperiods: the first two decades when the growth rate of urban TFP is higher, and the subsequent three decades, in which TFP growth in agriculture is more important.The initial increase in urban sector TFP is mirrored in a higher productivity of labour and hence higher wages in non-agriculture. Consequently, the expected lifetime utility of being employed in the urban sector increases to a higher value, making jobs in the urban sector more attractive. Workers in the rural sector start to migrate, even though they are not going to be employed as soon as they arrive in the city.[24] In other words, the lifetime utility of being unemployed is higher, during transition, than that of working in the agricultural sector, due to the fact that it takes into account the possibility of eventually getting a job with a higher wage. This is essentially the same mechanism underlying the Harris and Todaro (1970) model, with the difference of considering expected lifetime utilities, rather than expected wages. In the meantime, given migration, the marginal product of labour increases also in the agricultural sector, driving up wages and lowering the incentive to migrate. We therefore observe an initial acceleration of structural transformation, as measured by the share of employment in agriculture, followed by a slowdown when growth in urban TFP declines. However, as indicated by figure 2, the model delivers structural change which is much too fast, as the simulated agriculture employment share lies significantly below the observed real one.

The incentive to migrate is lowered even further when transition enters in the second subperiod. The increase in agriculture TFP, driving up the relevant wage, reduces the wage differential and hence the prospective gains from migration. Actually, we can observe a certain amount of reverse migration, in that the agriculture employment share increases slightly. This additional unattractive feature of the model is directly related to the exogenous behaviour of the relative price (top right panel in figure 1): a stronger reduction in the relative price would be required to counterbalance the observed increase in agriculture TFP. Since in this baseline case, given the openness assumption, we are fitting the path of the relative price to that observed in the data, we need not specify any structure of preferences. In section 7.1. the case of a closed

[24] Note that equation (4) does not take into account the possibility of immediate employment after migration.

economy will be analyzed, making clear all the differences implied by this alternative assumption.

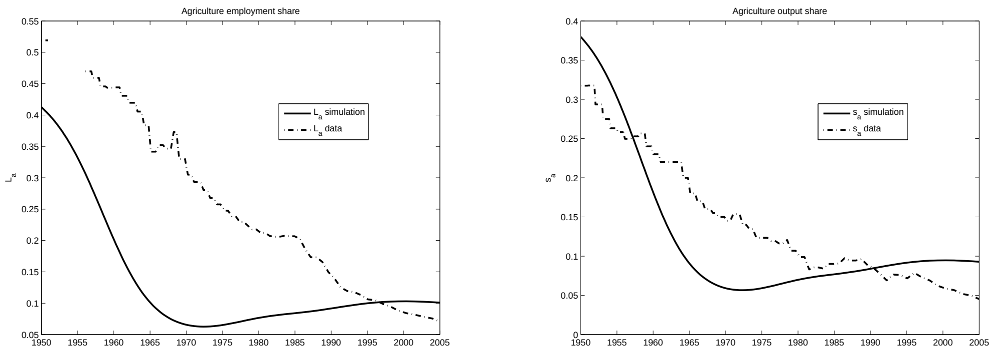

Figure 2: Structural transformation - baseline

The unsatisfactory performance of the model in terms of structural transformation is confirmed also when looking at the agriculture output share (right panel of figure 2). Similarly to employment shares, there is too much structural change relative to that observed in the data at the beginning, and reverse migration in the second subperiod translates into an unrealistic increasing share of agriculture output.

When looking in more detail at the behaviour of the labour market, however, we can find some better news. The model is indeed able to account for at least part of the increase in unemployment that Spain faced in the second subperiod. As can be noted from figure 3, unemployment more than doubles during the transition. However the model is not able to account for all of the increase. This may be due to the fact that in the early 1980s, Spain, as well as most of the European countries, introduced different measures to increase flexibility in the labour market, mainly through temporary and part-time contracts. This institutional change, often thought to be at the base of the sudden increase in Spanish unemployment in the last 30 years, is not taken into account in the baseline simulation. However, structural transformation can account for at least half of it.[25] An easy way to introduce some flexibility in the labour market, at least in a reduced form, may consist in allowing the job separation parameter to exoge-

[25]The fact that the simulated unemployment rate line does not start from values similar to those observed in the 50s has to be traced back to the too "compact" structure of the model, that does not permit to calibrate any possible starting point, without failing to match some other aspects of the data. This is a problem partially addressed in (Monteforte, 2012), where the greater richness of a model with search frictions allow us a more precise calibration.

nously increase over time, in a fashion similar to that adopted for other variables using (31). This will be investigated in section 7.1..

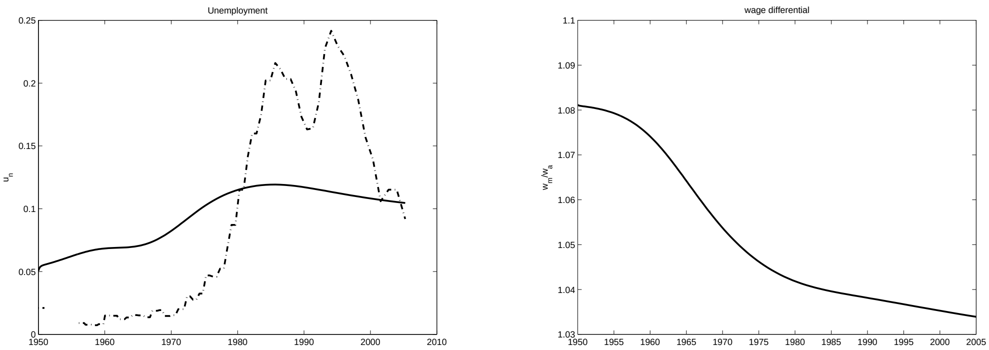

Figure 3: Labour market - baseline

Finally, a comparison between the two panels in figure 3 helps to account for the mechanism underlying the labour market when new workers migrate from the agricultural sector. The right panel in figure 3 depicts the behaviour of the wage differential as measured by the ratio of the urban to the traditional wage. At the beginning it is high, and starts to reduce when migration occurs, reflecting a stronger increase in the marginal product of labour in agriculture rather than in non-agriculture. Urban wage growth is kept lower because of the deterring effect of unemployment, which starts to increase when firms in the city are not able to absorb all excess labour supply. In this sense, unemployment works as a discipline device just as in the standard Shapiro and Stiglitz (1984) model. This effect is stronger in the first subperiod rather than in the second, when unemployment roughly doubles and the wage differential reduction is steeper. The second subperiod, when the agriculture TFP increase is not fully counterbalanced by the reduction in the relative price, sees a deceleration in unemployment growth (turning into a reduction since 1985), which is translated in a less strong reduction in the wage differential, in response to the lower strength of unemployment as a discipline device for urban wages growth: since workers in the city would face a lower penalty in case of being caught shirking, firms must pay higher wages to secure the required work effort.

7.1. Results under alternative assumptions

In this section alternative assumptions about openness and the labour market will be investigated and compared with the baseline results, to stress their importance for structural change and the simulation results in general.[26] In particular, as suggested in section 7. above, a first alternative considers the case of a closed economy, in which the price therefore responds endogenously to changes in demand for goods in both sectors. It is important to study this alternative setting because, as Matsuyama (1992) and Matsuyama (2008) demonstrate, the same model of structural transformation might deliver opposite predictions depending on the assumption on openness.[27] On the other hand, the second alternative keeps the small open economy assumption, but introduces a time-varying job separation rate on the same lines of the other exogenous time-varying parameters, using the law of motion in (31). This is done to account, at least in a reduced form, for the labour market reforms that introduced more flexibility in the Spanish labour market during the 1980s.

Starting with the closed economy assumption, since the price is now endogenous, a certain structure of preferences needs to be specified, in order to obtain an extra equation which pins down the price from sectoral demands for goods. This was done in section 4., where the particular structure of preferences adopted takes the Stone-Geary form (equation 21), in order to embed Engel's law effects in agriculture. With this formulation, the relative price is determined by (25). However, in (25) three extra parameters are present: γ_a, γ_m and λ_p. Their choice in the calibration exercise was done to deliver the same initial relative price of the baseline case (for comparability) and to match the unemployment rate and output shares in 2005. Indeed, the presence of these extra parameters adds flexibility to the model, permitting a more precise calibration.[28]

Results of the simulation under the closed economy assumption are summarized in

[26] A third extra experiment involved the specification of a model with heterogeneity in savings, following the Kaldor-Pasinetti hypothesis of a higher saving rate for capital owners than workers. However, the simulation under this alternative assumption did not yield any noticeable difference from the baseline case, hence it is not reported. The main reason for this result being the similarity in observed labour shares across sectors, which prevents enough income accumulation for capital owners.

[27] In particular, the closed economy assumption makes the agricultural employment share to be inversely related with the respective sectoral TFP, implying an Engel's law type of effect, when there are increases in agricultural TFP. On the contrary, the small open economy assumption implies a direct relation between agricultural employment share and TFP, which shifts comparative advantage (and hence employment) towards agriculture.

[28] Relevant values for the three extra parameters are not reported here, but are available upon request.

figures 4 and 5 below. For comparability the same starting points have been imposed as in the baseline case. From the viewpoint of structural change, the model performs significantly better, although there is still some discrepancy with the data. Both agricultural shares of employment and output (top panels in figure 4) display a path much closer to that observed in the data.[29] Structural change now happens more gradually and the awkward problem of reverse migration in the second subperiod is not present. This is because the relative price can now fully respond to changes in relative demands for goods in both sectors, with the other side of the coin being a less good fit of the relative price path in the data (lower left panel in figure 4). Indeed, under a closed economy, the price initially overshoots, in response to the increase in urban TFP. The non-agricultural sector gets bigger, and thus increases its demand for food, driving up the price. Once the economy is rich enough, Engel's law effects gain importance, because of the low (below one) income elasticity of demand for the agricultural good, and the price starts to decrease. The overshooting therefore permits a greater reduction in the relative price, which counterbalances the increase in agriculture TFP in the second subperiod, avoiding reverse migration and actually reinforcing the process of structural change in the right direction.

The initial increase in the relative price translates into a faster reduction of the wage differential (lower right panel in figure 4): wages in agriculture grow at a faster rate than in non-agriculture. The reduction slows down when the economy enters in the second transitional subperiod. This is again mainly due to the greater reduction in the relative price which effectively counteracts the beneficial effects of agriculture TFP growth and migration towards non-agriculture.

Looking more in detail at the labour market of the closed economy, the main consideration to be drawn is about the effect of the more gradual migration process on the path of unemployment. As can be noted from the first panel in figure 5, slower migration, because of the initial increase in the relative price, is translated into a flatter profile of the share of population living in the city. This means that the increase in non-agriculture TFP is able to absorb more of the unemployed present in the urban sector, making the unemployment rate decrease in the first ten to fifteen years. The pattern is

[29]The remaining difference in this case has to be fully addressed to the too rigid structure of the model that does not permit any calibration of the parameters to match the initial shares.

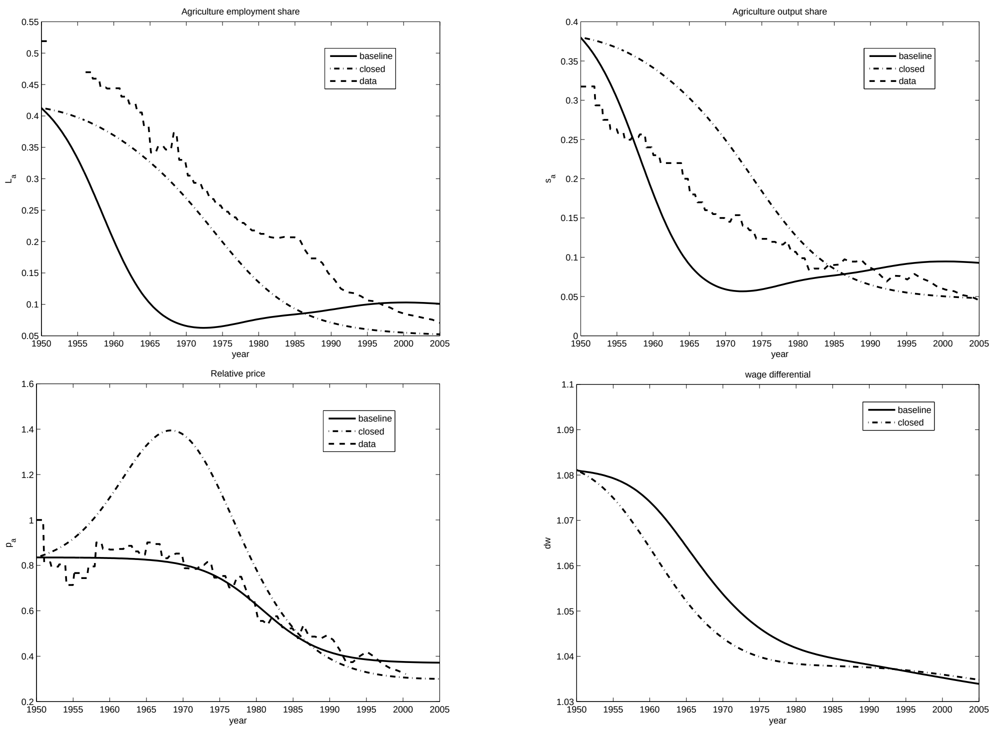

Figure 4: Structural transformation - closed economy

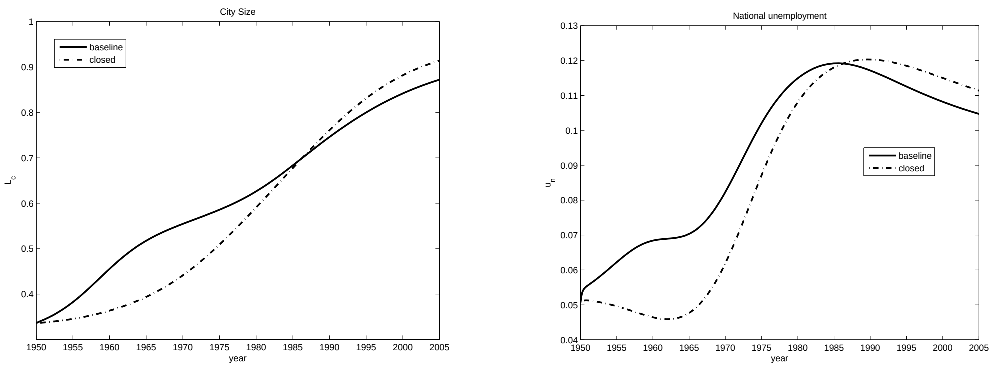

Figure 5: Labour market - closed economy

reversed when non-agricultural TFP growth decelerates and the effects of Engel's law, paired with accelerating TFP growth in agriculture, stimulate structural transformation.

The second alternative assumption explored in this section relates to the evidence of an increase in Spanish labour market flexibility, which was not directly accounted for in the baseline model. As suggested earlier, during the 1980s Spain, as well as many other European countries, introduced several reforms aimed to increase labour market flexibility, in particular through the introduction of temporary and part-time contracts. As reviewed in Dolado et al. (2002), industrial relations under the dictatorship were based on rigid employment and a ban on trade unions in exchange for lifetime job stability. The first reform, introduced in 1984, encouraged the use of fixed-term contracts by establishing lower severance payments and excluding the possibility of appealing to labour courts. Then the later reforms of the 1990s aimed at reaching a more balanced situation, when employment protection for permanent contracts was relaxed and that of temporary contracts restricted. However, the net effect of these reforms may have been a substantial increase in flows in and out from unemployment. Petrongolo and Pissarides (2008) calculate that, although in the last 20 years (1987-2006) both flows contributed in equal part to unemployment volatility, in the early 1990s nearly two thirds were attributable just to inflows into unemployment (mainly expiration of fixed-term contracts). To partially account for this increase, we introduce an extra logistic equation of the same form of (31), capturing an increase of the job separation rate λ from an initial value of 0.1 on an annual basis (the lower bound), to its final value of 0.2 (upper bound) as measured by Petrongolo and Pissarides (2008).[30] The calibration of the relevant speed parameter was then obtained by imposing the inflection point of the logistic (the year of maximum growth of λ) to coincide with the year of introduction of the first reform, 1984.

Relevant results under this alternative assumption are reported in figure 6, where now the solid line denotes a baseline case in which the job separation rate has been kept constant at the lower bound for comparability.[31] The dashed line considers instead the case of an increasing λ. As can be noted by the top panels in figure 6, virtually no effect can be detected in terms of structural transformation: for all the first subperiod the two lines overlap, both when looking at agriculture's shares of employment and/or output. In the second subperiod, the reverse migration problem is slightly reinforced when the job separation rate is varying over time. This is because with an increasing chance of job loss, the expected relative gains from urban location are re-

[30] Petrongolo and Pissarides (2008) calculate quarterly exit rates based on three labour states: employed, unemployed, out of the labour force. Since the model does not consider the inactivity choice, the two exit rates from employment have been added together and converted to annual terms.

[31] The simulation under this alternative assumption has been done going back to the original small open economy setting.

duced.

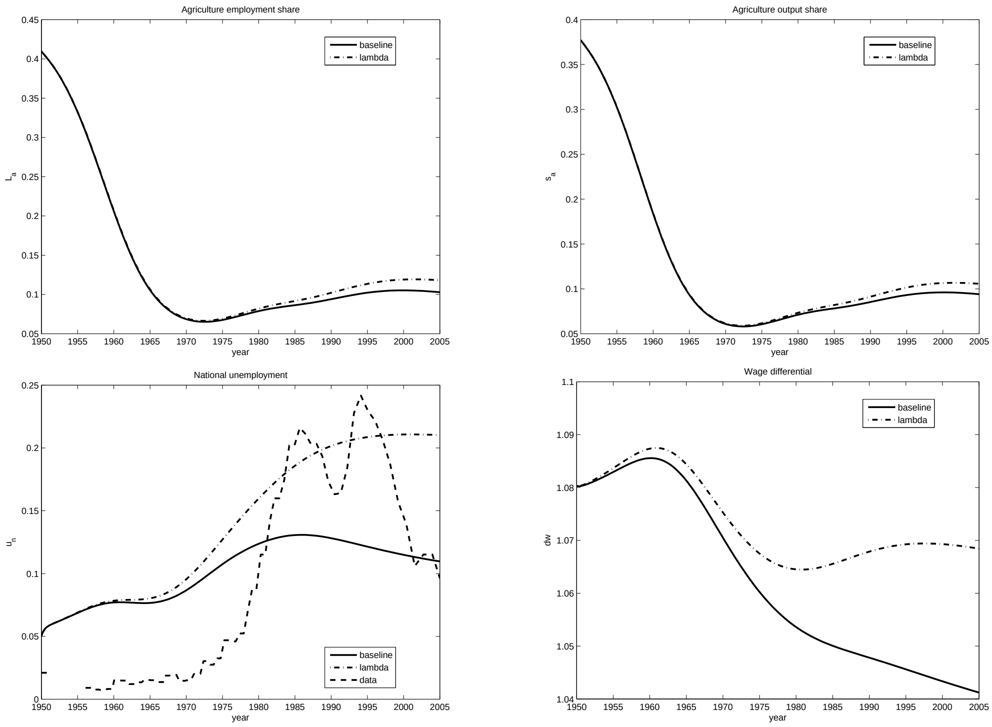

Figure 6: Simulation with increasing λ

Perhaps more interesting are the dynamics of the labour market. Although nothing relevant happens in terms of structural change, in the lower left panel of figure 6 it can be noted how the performance of the model substantially improves in terms of fitting the unemployment rate data. Once job separations significantly increase, the unemployment rate reaches levels of around 20 percent, as observed in the data.[32] Another distinctive feature of the simulation under this alternative assumption is given by the behaviour of the wage differential, which, as can be noted in the lower right panel of figure 6, although reducing over time, remains at higher values than in the baseline. However, following the efficiency wages hypothesis, the bigger increase in unemployment could have hindered growth in urban wages because of the associated increased

[32]Of course it was not possible to replicate the U pattern between 1986 and 1994, which is entirely attributable to two exogenous shocks not accounted for in the model: the 1986 adhesion to the European Economic Community for the downward sloping part, and the 1991-94 European recession for the upward sloping part. The same argument applies in opposite terms for the sharp reduction in the last decade. See Bentolila and Jimeno (2006) for more details.

penalty from shirking, suggesting a greater reduction in the wage differential. This apparently contrasting evidence can be rationalized when looking back at the dynamic no-shirking condition in (10). In that equation it can be noted that, together with the number of unemployed workers which enter the relation inversely (confirming that unemployment and monitoring are substitutes), there is direct proportionality between the job separation rate and the urban wage. Since both λ and u_n increase over time, their effects on urban wages partially offset each other, implying a lower reduction in the wage differential. This effect is reinforced by the increased reverse migration process which reduces the marginal product of labour in agriculture and hence wages.

8. How much might increasing returns matter?

Having discussed the dynamic behaviour towards the steady state, we can now turn to growth considerations. The main objective of this section, in fact, will be to evaluate how much each component identified in section 5. contributes to the aggregate TFP growth rate implied by the model. Of course, the extent of this contribution is affected by the assumption on the extent of increasing returns present in the urban sector. In this respect, we have to add a note of caution about the results presented below. Available data on value added and factor compensations for Spain greatly limit the plausible extent of increasing returns in non-agriculture. In particular, computation of a standard Solow residual using EU-KLEMS data, with the additional assumption of (even) a very low degree of increasing returns ($\phi = 0.05$), would imply constant TFP throughout all the 30 years period for which data are available. Since this prediction seems unrealistic, the model in its baseline configuration was calibrated under constant returns. However, with the caveat of interpreting the model as no longer calibrated to Spain, but rather to an example model economy characterized by the same parameter values as the baseline case, but with the presence of externalities, we can still use the same model to investigate the potential importance of increasing returns to aggregate TFP growth.

We choose to calibrate the model under two alternative assumptions about the strength of increasing returns: (i) $\phi = 0.1$ (moderate degree of increasing returns); (ii) $\phi = 0.2$ (high degree of increasing returns). Although quite arbitrary, we believe these assumptions to be in the right ballpark of current available estimates of increasing returns.[33] However, the empirical literature about the strength of externalities in the non-agricultural sector is not unambiguous. Among others, Antweiler and Trefler (2002) provide estimates for the manufacturing sector, based on a general equilibrium model of international trade, whose implied value for ϕ has a modal range of $0.10 - 0.20$.[34] But they warn that other estimates, this time based on a partial equilibrium framework, are less clear cut, especially for middle-income and rich countries: the implied values for ϕ in some cases start from a minimum of 0.20, while in others there is no evidence of increasing returns at all.

Park and Ryu (2006) provide, along with another set of estimates of scale effects for some East Asian countries and for a group of five developed countries, an evaluation of the contribution of scale effects to output growth rates, with a decomposition that takes into account the scale component versus the non-scale component, which is in turn decomposed into the contribution of each factor of production (technical progress, physical capital and labour).[35] The empirical evidence for increasing returns found in their study suggests a higher extent of increasing returns (and therefore a higher percentage contribution to growth) in the newly industrialized economies with respect to the developed ones: the relevant figures show a contribution around 10% and 15% of output growth and imply a relative contribution of increasing returns to aggregate TFP growth between 20% and 42%.

There are however studies which, contrary to our growth accounting calculation, do find a certain amount of increasing returns for Spain's manufacturing sector, at least in the period 1980-1995. This is the case, for example, of Estrada and López-Salido (2004), who estimate an adjusted Solow residual equation that accounts for the potential presence of imperfect competition and variable input utilization as well as increasing returns. They also provide a correction for the use of value added data (that is, net of

[33] The baseline case of constant returns was considered as a benchmark for comparison, also because increasing returns do have important consequences for the pure labour reallocation component, as explained later in more detail.

[34] The estimates we are referring to are those for the group of manufacturing industries that display IRS, comprising Pharmaceutical, Electrical and Electronic Machinery and Non-Electrical Machinery. The general figure for a cross-section of 71 countries, which does not distinguish by the type of industry, is between 0.06 and 0.11 depending on which estimation technique is used.

[35] The two samples of countries include, respectively: Hong Kong, Korea, Singapore and Taiwan, and the US, UK, France, West Germany and Japan.

indirect taxes), and estimate the parameter capturing the degree of homogeneity of the production function to be 1.19.

As suggested earlier, the calibration under increasing returns is based under the same parameter assumptions made in the baseline case. Furthermore, we make the economy start from the same point (in terms of state variables) and let the algorithm apply the relevant equation of motion until the steady state is reached. Of course, this implies that not all variables could start from the same values, as in the baseline, as some of them are jump variables which immediately adjust to ensure the static equations hold at every point in time.

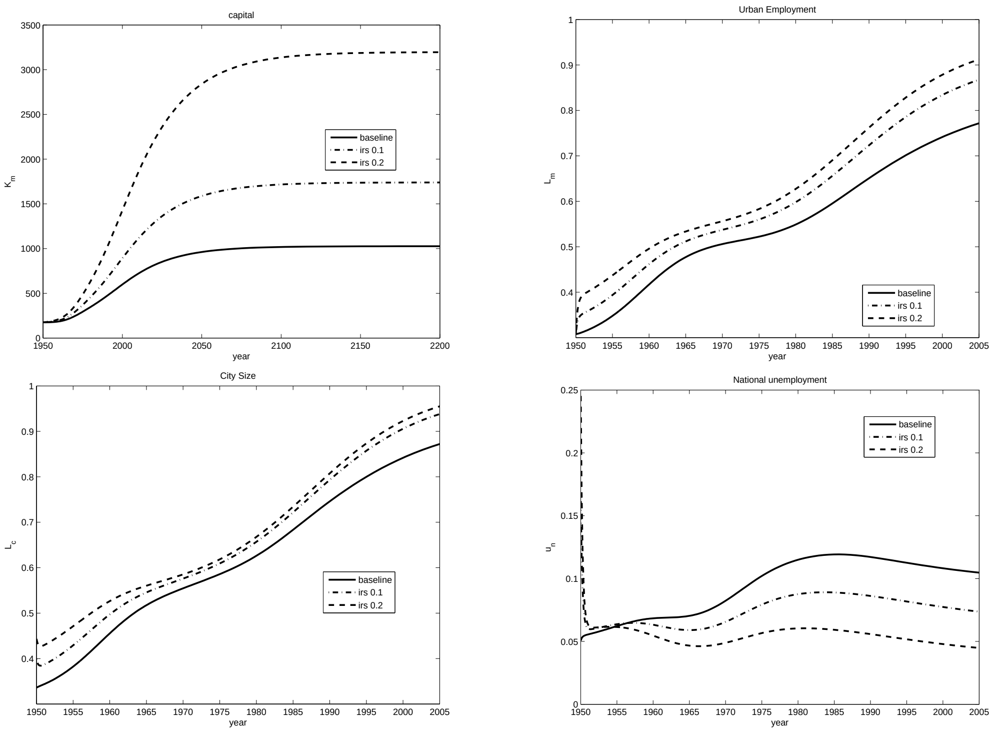

Figure 7: Initial conditions and labour market - increasing returns

The above argument can be seen when looking at figure 7, where the top panel depicts the time-paths of the two endogenous state variables K_m and L_m. The economies start from the same amount of factors of production in non-agriculture (which are the two state variables of the system (15)-(19)), but as expected the presence of increasing returns leads to higher capital accumulation and employment in the steady state. However, the size of the sector (L_c) is a jump variable of the model, implicitly determined at each instant by the forward looking migration condition in (18). Thus, as we can observe in the lower panels of figure 7, L_c jumps on the higher growth path since the very beginning. Consequently, unemployment starts from very high values at the beginning (because of the jump in L_c), but reduces very quickly because of increased hires with increasing returns and keeps a path similar to the corresponding one in the baseline, but consistently at lower values.

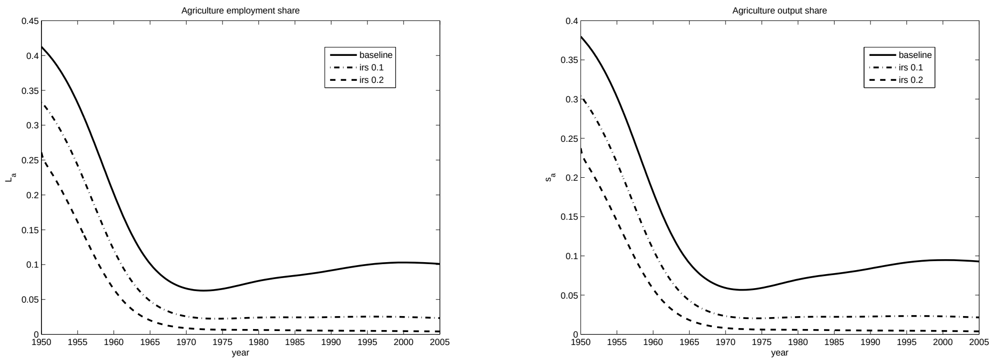

Figure 8: Structural transformation - increasing returns

From the point of view of structural change, assuming increasing returns has the major consequence of solving the unattractive feature of reverse migration in the second subperiod. As non-agriculture displays amplified productivity growth, validity of (13) at every point in time does not imply reallocation of workers to agriculture anymore. The panels in figure 8, where the agriculture shares of output and employment are depicted, offer a confirmation.[36]

We now proceed to the examination of the relative contribution of each component isolated in section 5. to aggregate TFP growth. The results are depicted in figure 9, where each component's contribution is expressed as a share of the aggregate TFP growth that would be naively calculated applying standard growth accounting (as just the difference between growth in output and share-weighted input growth). Transition in the model is induced by an adjustment process of sectoral TFPs to their long run world values. Therefore, it is not surprising that they play the bigger part, at least in the baseline case. As can be noted by the solid lines in the upper panels of figure 9,

[36]As both shares depend on the relative size of the sectors, it is again not surprising that under increasing returns the path start from different initial points.

growth in urban TFP is what matters in the first subperiod (averaging around 91 pp.), while agriculture TFP growth takes the lion's share in the second (average of 78 pp.). Symmetry across sectoral TFPs ceases to exist when considering increasing returns: if urban TFP's contribution displays a behaviour similar to the baseline, this is not the case for agricultural TFP, whose contribution is now substantially lower (averages are 19 pp. for $\phi = 0.1$ and 3 pp. for $\phi = 0.2$). This is the consequence of increasing returns gaining importance with the increasing size of the sector (lower right panel of figure 9). Although in the first subperiod most of the aggregate TFP growth is attributable to technology growth in the urban sector, in the second subperiod increasing returns account on average for 57 pp. even when assumed of moderate degree (and 80 pp. with $\phi = 0.2$).

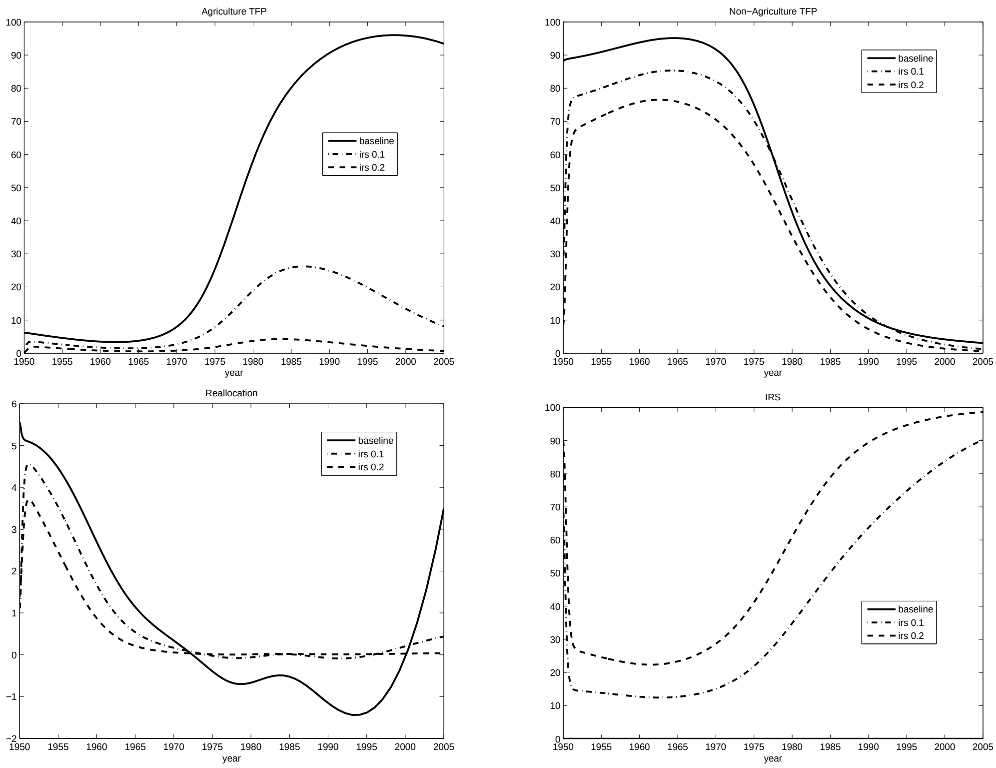

Figure 9: Growth accounting

The final contribution to be analyzed is that of labour reallocation, quantified as in (29). Since the calibration of the model in the baseline, as well as under increasing returns, implies a low wage differential (wages in the urban sector start from just 8 percent higher than in agriculture), it is not surprising that the share of labour reallocation in overall aggregate TFP growth is low. It is obviously higher in the first subperiod, when the bulk of structural transformation takes place (average of 3 pp. in baseline, 2 pp. with $\phi = 0.1$ and 1.5 pp. with $\phi = 0.2$), and becomes negligible in the second subperiod. Furthermore, the limit of the model in the baseline, which delivers reverse migration in the second subperiod, implies the percentage contribution is negative during that time.

9. Conclusions

This study tries to address two main points: (i) the transitional behaviour of a dual economy in which one of the two sectors is characterized by involuntary unemployment and increasing returns; (ii) the implications of the presence of increasing returns for aggregate TFP growth. To address these questions, we have developed a dynamic version of the Moene (1988) model, in which the presence of increasing returns in the modern sector was added. In its baseline configuration, the model describes a small open economy. Results from the simulation of Spanish postwar structural transformation give a contrasting picture: the model delivers too fast structural change at the beginning of the period, when non-agriculture TFP growth is stronger, and, in its baseline configuration, is not able to replicate the continuing structural transformation of the second subperiod. Indeed, it yields an awkward prediction of (modest) reverse migration in the years 1975-2000. On the other hand, the model replicates nearly half of the increase in postwar Spanish unemployment, where the rest may be accounted for by more flexible labour market regulations and business cycle effects.

The performance of the model significantly improves if a closed economy is assumed. Indeed, when the relative price is not constrained to an exogenous path, and can freely respond to changes in sectoral demand for goods, the speed of structural transformation becomes similar to that observed in the data. On the other hand, the simulation implies overshooting of the relative price, which increases in the first subperiod and reduces quite sharply in the second. Another limitation of the model is its inability to account for all the observed increase in the unemployment rate. Considering the alternative assumption of an exogenous increase of the job separation rate over time, the model significantly improves in this dimension, suggesting that the part of unemployment growth not accounted for by structural change has to be attributed to reduced employment protection over time.

The model was then used to study the importance of increasing returns in the process of structural transformation, to assess Kaldor's claim of their relative importance in aggregate TFP growth. To this end, a new decomposition of the standard Solow residual is proposed, including a third component (related to increasing returns) in addition to the standard two already isolated in the dual economy literature (respectively related to technological progress and labour reallocation). Furthermore, the decomposition proposed here takes into account the presence of involuntary unemployment. Results suggest that increasing returns gain importance for aggregate TFP growth mainly in the second subperiod (the years 1975-2005), when the beneficial effects of TFP in non-agriculture have expired, and reduce by a great deal the relative importance of agricultural TFP growth. In this sense, the evidence found in this paper points towards the support of Kaldor's claims, suggesting that productivity gains in non-agriculture pull workers out of the traditional sector. In some ways this counteracts the literature that finds the main source of structural transformation to be TFP growth in agriculture, which encourages the release of workers from agriculture to industry.

Obviously the model could be extended and improved in a number of directions to overcome some of its limits. Among others, it could account for labour market heterogeneity, to consider explicitly both permanent and temporary contracts. It presents a simple version of increasing returns, maintaining exogenous productivity growth, while more interesting features could emerge when TFP growth is endogenized, either through learning-by-doing (Matsuyama, 1992), or through models with an increasing variety of products as surveyed in Matsuyama (2008). Growth accounting exercises would then need to be adapted accordingly, following the methods already set out in Barro and Sala-i-Martin (2004). Furthermore, the model's "compact" structure does not permit a satisfactory calibration of the target economy's initial conditions: a model with a richer description of both the labour market and sectoral production technologies might help in this regard. This effort has been undertaken in (Monteforte, 2012) and (Monteforte et al., 2012). However, overall the model is still helpful in highlighting the role played by increasing returns in the process of structural change, and provides a useful starting point for their study in more complex environments.

10. Appendix

10.1. Growth accounting with increasing returns and involuntary unemployment

In this appendix we will show how the decomposition in section 5. was derived. Starting from equation (26) in the text the first term can be re-written as:

$$s_a\frac{\dot{Y}_a}{Y_a} = s_a\frac{\dot{A}_a}{A_a} + \nu\frac{\dot{R}}{R} + \varphi\frac{\dot{L}_a}{L} \tag{32}$$

where φ was defined in section 5. and $\nu = \frac{r_R L}{Y}$, with r_R denoting the marginal product of land. The second term can be re-written as:

$$(1-s_a)\frac{\dot{Y}_m}{Y_m} = (1+\phi)(1-s_a)\frac{\dot{A}_m}{A_m} + (1+\phi)(1-\omega-\nu)\frac{\dot{K}_m}{K_m} + d\varphi\frac{\dot{L}_m}{L} + \phi d\varphi\frac{\dot{L}_m}{L} \tag{33}$$

Noting that $L = (1-a-u_n)L_m$, the last term of the above equation can be written as:

$$\phi d\varphi\frac{\dot{L}_m}{L} = \phi d\varphi(1-a-u_n)\frac{\dot{L}_m}{L_m}. \tag{34}$$

Combining all the equations above yields:

$$\begin{aligned}\frac{\dot{Y}_{real}}{Y_{real}} &= (1+\phi)(1-s_a)\frac{\dot{A}_m}{A_m} + s_a\frac{\dot{A}_a}{A_a} + \\ &\quad + \nu\frac{\dot{R}}{R} + (1+\phi)(1-\omega-\nu)\frac{\dot{K}_m}{K_m} + \\ &\quad + \phi d\varphi(1-a-u_n)\frac{\dot{L}_m}{L_m} + \varphi\frac{\dot{L}_a}{L} + d\varphi\frac{\dot{L}_m}{L}\end{aligned} \tag{35}$$

The last two terms in the equation above can be re-written as:

$$\begin{aligned}\varphi\frac{\dot{L}_a}{L} + d\varphi\frac{\dot{L}_m}{L} &= \varphi\frac{\dot{L}_a}{L} + \varphi\frac{\dot{L}_m}{L} + (d-1)\varphi\frac{\dot{L}_m}{L} \\ &= \varphi\frac{\dot{L}_e}{L} + \varphi(d-1)\frac{\dot{L}_m}{L} \\ &= \varphi(1-u_n)\frac{\dot{L}_e}{L_e} + \varphi(d-1)(1-a-u_n)\frac{\dot{L}_m}{L_m} \\ &= \omega\frac{\dot{L}_e}{L_e} + \varphi(d-1)(1-a-u_n)\frac{\dot{m}_e}{m_e}\end{aligned}$$

where L_e and m_e were defined in section 5. and the last line follows from using equation (27). Therefore we can decompose the output growth rate as:

$$\begin{aligned}\frac{\dot{Y}_{real}}{Y_{real}} &= (1+\phi)(1-s_a)\frac{\dot{A}_m}{A_m}+s_a\frac{\dot{A}_a}{A_a}+\\ &+\nu\frac{\dot{R}}{R}+(1+\phi)(1-\omega-\nu)\frac{\dot{K}_m}{K_m}+\\ &+\phi d\varphi(1-a-u_n)\frac{\dot{L}_m}{L_m}+\\ &+\omega\frac{\dot{L}_e}{L_e}+\varphi(d-1)(1-a-u_n)\frac{\dot{m}_e}{m_e}\end{aligned} \tag{36}$$

Appropriately rearranging terms, setting to zero those which are assumed not to grow over time, and remembering that the standard Solow residual in this framework is equal to:

$$\frac{T\dot{F}P}{TFP}=\frac{\dot{Y}_{real}}{Y_{real}}-(1-\omega-\nu)\frac{\dot{K}_m}{K_m}-\omega\frac{\dot{L}_e}{L_e}$$

yields the expression presented in section 5..

10.2. Logistic functions

At several points in the calibrated model, we use logistic functions which take the following form:

$$Z(t)=Z_L+\frac{Z_H-Z_L}{1+A\exp(-\phi(Z_H-Z_L)t)} \tag{37}$$

where the constant $A\equiv(Z_H-Z_L)/(Z(0)-Z_L)-1$. It can be shown that this expression implies

$$\dot{Z}=\phi(Z(t)-Z_L)(Z_H-Z(t))$$

which is the form of the differential equations used for sectoral TFPs, the relative price of the agricultural good, the replacement ratio, and the labour force. In the case of the first two, we estimate the parameters of (37) from the data using non-linear least squares.

In cases where ϕ is imposed rather than estimated from the data, we use the formula

$$\phi = \ln\left(\frac{Z_H - Z_L}{Z(0) - Z_L} - 1\right) / \left(T(Z_H - Z_L)\right)$$

where T is a user-specified constant, equal to the desired number of years after the beginning of the process at which the point of inflection is to occur.

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