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Conference Paper

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Beiträge zur Jahrestagung des Vereins für Socialpolitik 2019: 30 Jahre Mauerfall - Demokratie und Marktwirtschaft - Session: Macroeconomics - Growth I, No. C08-V3

Provided in Cooperation with:

Verein für Socialpolitik / German Economic Association

Suggested Citation: Schmöller, Michaela (2019) : Stagnant Wages, Sectoral Misallocation and Slowing Productivity Growth, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2019: 30 Jahre Mauerfall - Demokratie und Marktwirtschaft - Session: Macroeconomics - Growth I, No. C08-V3, ZBW - Leibniz-Informationszentrum Wirtschaft, Kiel, Hamburg

This Version is available at:

<https://hdl.handle.net/10419/203598>

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Stagnant Wages, Sectoral Misallocation and Slowing Productivity Growth

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January 24, 2019

Abstract

I propose a two-sector endogenous growth model with heterogeneous sectoral productivity and nonlinear hiring costs to analyse the link between sectoral resource allocation, low productivity growth and stagnant real wages. My results suggest that an upward shift in employment, triggered for instance by a labor market reform, is beneficial in the long-run as it raises growth of technology, labor productivity and real wages. I show, however, that a slowdown in productivity and stagnation of real wages can in this setting constitute two sides of the same coin as a result of the shift in employment: In the immediate phase following the shock, labor productivity and real wages stagnate as employment gains are initially disproportionately allocated to the low productivity sector which limits the capacity for technology growth and depresses real wages and productivity. I show that due to the learning-by-doing growth externality in the high productivity sector the competitive equilibrium is not efficient as firms fail to internalize the effect of their individual labor allocation on aggregate growth. Subsidies to high productivity sector production constitute apt policy tools to alleviate welfare losses along the transition path.

JEL codes: E20, E24, E60, O40, O41

Keywords: Subdued Wage Growth, Productivity Slowdown, Misallocation, Endogenous Productivity Dynamics, Labor Market Policies

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Disclaimer: The views expressed are those of the author and do not necessarily reflect those of the Bank of Finland.

1 Introduction

In recent years many advanced economies have experienced a sustained slowdown in productivity growth which has generally set in already in the early 2000s and has gained particular attention in the years following the Great Recession. Additionally, the persistently sluggish wage development in many advanced economies, which has widely prevailed even in the context of increasingly tight labor markets, has represented a phenomenon central to the policy discussion. Simultaneously, several of these economies experienced a sustained upward shift in employment, triggered by means of two major channels. On the one side, labor market policies aimed at raising aggregate employment were an important driving force. The large-scale labor market reforms implemented in Germany from 2003 to 2005, the so-called "Hartz" reforms, constitute a prominent example in this context. In other countries, in turn, migration can be considered the main driver of the employment shift. In this context, the experience of the United Kingdom - characterized by a pronounced productivity slowdown, stagnant real wage growth, rising employment and simultaneous significant net migration - is particularly notable.¹

This paper draws on the experience of a simultaneous stagnant wage development and slowing productivity growth in the presence of pronounced employment expansions. I propose a tractable mechanism which demonstrates that both the phenomenon of stagnant wage and productivity growth can be the result of an initial misallocation of production factors to low productivity sectors following a positive shock to employment. For that purpose, I construct a nonlinear two-sector endogenous growth model with heterogeneous productivity across sectors where technology advances are concentrated in the high productivity sector which constitutes the growth engine in the economy. More specifically, the model is subject to an endogenous total factor productivity mechanism of the learning-by-doing type in which technology growth is increasing in the labor allocated to the high-growth sector. Labor is generally homogeneous and mobile. However, nonlinear labor adjustment costs in the high productivity sector represent a constraint to the instantaneous flow of labor to the high productivity sector. These adjustment costs only occur in the case of hiring, reflecting the costs from initial training, learning of complex production processes and the adjustment of human capital to the production requirements in this sector and thus reflecting the corresponding costs of hiring. By means of this framework, I demonstrate that exogenous upward shifts in employment are general

¹While the case of Germany represents a clear-cut example of a large-scale labor market reform and stands thus in the focus of this analysis, several further countries have implemented similar labor market reforms focused on raising the labor supply, with Sweden and Denmark as noteworthy examples. Moreover, further euro area economies implemented labor market reforms following the Great Recession and euro area debt crisis.

desirable since they increase the rates of both technology and productivity growth and also foster real wage growth in the long-run. My analysis further shows, however, that over the short- to medium-term slowing productivity and real wage growth can constitute two sides of the same coin resulting from the employment shift as labor productivity and real wages stagnate in the initial phase following the positive employment shock. I show that due to the presence of a growth externality resulting from the learning-by-doing process in the high productivity sector, the competitive allocation is inefficient. The cause of the inefficiency is that firms in the high productivity sector do not internalize the impact of their own hiring choices on aggregate growth performance. These inefficiencies in the decentralized economy give a role for policy intervention: Subsidizing production in the high productivity sector is an effective policy tool to reduce the initial extent of misallocation following the employment shock and thus an adequate policy measure to reduce welfare losses occurring along the transition to the new equilibrium.

This paper relates to various strands of the literature. Firstly, it is linked to the original literature on resource misallocation, commonly referred to as "the Dutch disease". Initially pioneered by Corden and Neary (1982), these studies focus on the adverse effect which the discovery of natural resources can exert on economic performance and welfare.² A specific subset of these papers analyses the effect of the prevalence of natural resources also via learning-by-doing on economic growth in this context and are thus especially close to this paper (see for example Krugman, 1987 and Matsuyama, 1992). In my paper, however, it is not the richness of natural resources but instead the abundance of the production factor labor which triggers the misallocation towards stagnant sectors. That given, this paper is also tightly linked to the cost disease in the service sector, the so-called "Baumol disease", as the latter also addresses the role of relative labor allocation across sectors which are heterogeneous in productivity on the performance of the aggregate economy. More specifically, the Baumol disease (see Baumol and Bowen, 1966 and Baumol, 1967 for reference) centers around the observation that while generally wage rises are to reflect increases in labor productivity, also sectors which do not display productivity growth can experience wage pressures given the need of attracting workers also to this sector. Work on the Baumol disease further points out - as does this paper - that aggregate productivity growth as well as real output growth may stagnate resulting from the drag stagnant sectors exert on the total economy. As a result, preferences for the consumption of goods produced in low productivity sectors may induce a state in which the economy and real incomes stagnate given the increasing demand of services subject to limited inherent capacities for productivity growth - coining the notion of "unbalanced growth". Hence, the model I present features an episode in which the Baumol disease mechanism of the misallocation

²See Frankel (2011) and Van der Ploeg (2011) for a review of this strand of the literature.

of labor to stagnant sectors is active. The latter is, however, and in contrast to these studies, only a temporary effect occurring on the transition path to the new equilibrium. Moreover, the channels inducing the stagnation of labor productivity and wage growth in my model differs from typical Baumol disease models as the trigger in this paper is a sudden expansion in employment.

Lastly, this paper is connected to theoretical analyses which investigate the drivers of the recently observed productivity slowdown. Closely related studies analyse the sources of the productivity slowdown by means of DSGE models with total factor productivity mechanisms in which TFP evolves endogenously as the result of R&D and technology adoption (Anzoategui, Comin, Gertler and Martinez, 2018; Bianchi, Kung and Morales, 2018; see Schmöller and Spitzer (2019) for a model-based analysis of the euro area productivity slowdown). Benigno and Fornaro (2017) present a Keynesian growth model with endogenous growth and nominal wage rigidities and emphasize the role of secular stagnation in this context. Furthermore, a particular relevant related strand of the literature studies misallocation in the context of the recent productivity slowdown. The misallocation in several euro area countries upon monetary union and interest rate convergence constitutes a major field addressed by recent research. Benigno and Fornaro (2014) present, drawing on the observation of large capital inflows and misallocation to low productivity sectors in Spain following EMU, a two-sector model (tradable vs. non-tradable) where the tradable sector constitutes the growth engine in the economy and technology growth evolves endogenously via a growth externality through learning by doing in the tradable sector. They demonstrate that a period of large capital inflows, prompted by a fall of the interest rate, induces a boom in consumption. The increase in tradable consumption is financed through borrowing from abroad, while the consumption increase of the non-tradable good necessitates a shift of production factors to the non-tradable, low-growth sector, inducing stagnation in productivity growth. Relatedly, Benigno, Converse and Fornaro (2015) document the channel between decreasing interest rates, large capital inflows and sectoral labor allocation empirically using data on middle- and high-income countries. Moreover, Gopinath et al. (2017) demonstrate that the decline of real interest rates observed in southern EMU countries upon monetary union induced a significant decrease in sectoral total factor productivity as a result of the misallocation of capital inflows toward firms with higher net worth but not necessarily higher productivity. In contrast to these studies, this paper does not focus on the role of low interest rates and large capital inflows as a trigger of sectoral misallocation but proposes a new channel for a misallocation-induced productivity slowdown resulting from an abundance of the production factor labor.

As one of the key motivating episode for this analysis constitutes the German experience following its large-scale labor market reforms from 2003 to 2005, studies analyzing the macroeconomic impact of the Hartz reforms are naturally closely related to this analysis. Most studies in this context focus on the direct labor market impact and document among others an increase in matching efficiency (Fahr and Sunde, 2009; and Klinger and Rothe, 2012) and a rise of atypical employment forms (see, for example, Rothe and Wälde, 2017). Theoretical studies on the macroeconomic level are scarce and typically focus on the decrease in unemployment and welfare in a search-and-matching context (Krause and Uhlig, 2012; Krebs and Scheffel, 2013) as well as the role of the German labor market reforms in the build-up of current account imbalances (see for instance Kollmann et al., 2015; Hochmuth, Moyen and Stähler, 2018). While these studies are important to understand potential effects of a large-scale employment shift on labor market outcomes as well as international implications, the effect of large-scale employment shifts on the evolution of aggregate productivity have largely been overlooked. Against this background, this paper takes a novel perspective on the issue and addresses the impact of an employment expansion from a macroeconomic, endogenous growth perspective and analyses the impact on the economy's technology growth and hence the economy's long-run growth rate. Moreover, to my knowledge, this is the first study which analyses the impact of these employment shifts on resource allocation and explores the role of misallocation in this context. Taking this approach furthermore also permits to disentangle dynamics over the short- to medium-term from long-run effects as well as to theoretically demonstrate the interaction between the employment shift, real wage growth and the evolution of productivity over various horizons. This paper further provides a welfare analysis and derives suitable policy tools for alleviating the inefficiencies arising in the competitive equilibrium.

The outline of this paper can be summarized as follows. Section 2 discusses stylized facts on the issue of stagnant productivity and wage growth following employment shifts. Section 3 demonstrates the model framework and hence the basis of this analysis. Subsequently, I present the results for the evolution of real wages as well as technology and labor productivity growth over both the short- to medium-term and in the long-run (section 4). Section 5 shows the inefficiencies in the competitive allocation by deriving the differences vis-à-vis the social planner equilibrium. Based on these findings, section 6 presents the corresponding implications and options for policy making in this context. Lastly, section 7 concludes.

2 Stylized facts

This section presents stylized facts on productivity growth, the evolution of real wages and employment shifts, with a special focus on the experience of Germany following its large-scale labor market reform. Figure 1 illustrates developments in Germany with regards to productivity, wages and employment over roughly the past three decades. A central observation in this context is that, after a phase of both relatively high labor productivity and real wage growth in the beginning of the sample, from the early 2000s onward both labor productivity and real wage growth began to stagnate for a sustained time period. This substantial slowdown in both productivity and real wage development illustrates also the flattening of the corresponding trend over the 2003 to 2012 period (orange line) vis-à-vis the pre-reform trend (blue line). Importantly, this episode overlaps with a large-scale labor market reform package - commonly referred to as the "Hartz" reforms, which was implemented from 2003 to 2005, and constitutes the largest change in the German social security system in the post-war period (for an overview of the main reform steps and labor market effects see Jacobi and Kluge, 2007 and Schmöller, 2013). A central aim of the Hartz reforms was to raise employment, induced above all by a substantial decrease of workers' outside option through a marked reduction of both unemployment benefit payments and entitlement periods. In addition, benefits were made conditional on proven active job search, severe penalties in case of non-compliance were introduced and the acceptance of suitable job offers was rendered mandatory. A further important reform step was the introduction of new employment forms with shorter standard weekly working hours to foster outflows of unemployment and inactivity into employment. These events translated into a large-scale shift in the evolution of employment in the follow-up of the reforms in the mid 2000s (see Figure 1, lower-left panel): Upon a sustained phase of high unemployment, employment has increased rapidly and continuously over the post-reform period. The employment level in 2013 exceeded its 2003 counterpart by roughly 9 per cent and has expanded further in the context of the economic expansion in Germany. Interestingly though, these large-scale employment gains have not been evenly distributed across sectors. Instead, employment increases were mostly realized in sectors with relatively low productivity while employment in high productivity sectors have stagnated following the labor market reform and have only started to increase towards the end of the sample period, as also illustrated in the lower-right panel of Figure 1. In sum, the experience in Germany has been characterized by stagnant real wage growth, a slowdown in productivity, as well as a substantial expansion of employment, which was disproportionately concentrated in low productivity sectors. This paper draws on this experience and proposes a model which reconciles these observations into a single, tractable theoretical framework. In particular, I propose a mechanism which demonstrates that

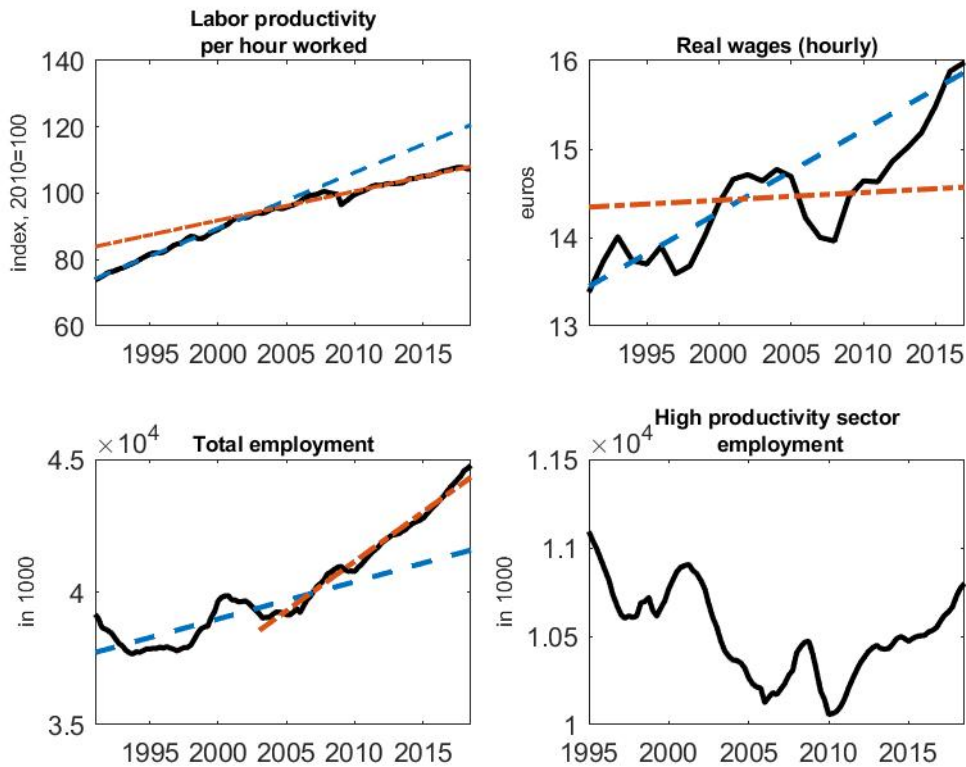


Figure 1: Evolution of productivity, wages and employment in Germany
 Upper-left panel: real labor productivity per hour worked, index (2010=100), quarterly and seasonally-adjusted data, source: Eurostat; upper-right panel: real earnings per employee hour worked, net, constant prices, resident concept, in euros, source: German Federal Statistical Office; lower-left panel: total employment, measured in 1000 workers, age: 15-64, source: Eurostat; lower-right panel: employment in high productivity sectors (defined as industry (excluding construction), information and communication as well as financial and insurance services), measured in 1000 workers; blue and orange lines indicate linear trends evaluated over the time period 1991q1 to 2002q4 and 2003q1 to 2012q4 respectively.

under certain circumstances, a slowdown in productivity and stagnant real wage growth, despite increasingly tight labor markets constitute two sides of the same coin as a result of the employment shock, following from an initial misallocation of production factors to low productivity sectors following a significant upward shift in employment.

While the case of Germany constitutes a clear-cut example of a large-scale expansion of employment triggered by a labor market reform and thus constitutes an important empirical motivating episode of the theoretical mechanism proposed in this paper, the insights of this analysis are not restricted to the case of Germany. Firstly, many further countries have implemented comparable labor market reforms. Denmark and Sweden constitute

notable examples. Moreover, several euro area economies implemented similar labor market policies following the recent crises in the euro area . While the focus of this analysis is the labor market policy-induced employment shifts with economic dynamics in Germany during the post-reform phase as a concrete example, a further potential channel can be found in migration, with the UK economy as a potential suitable example in this context: Also the UK experienced a pronounced expansion in employment, while simultaneously labor productivity growth has markedly slowed and real wages have stagnated over a sustained time period.

3 The model

We consider a perfect foresight, infinite horizon, closed economy. Let time be discrete and indicated by t . The model economy is inhabited by a continuum of mass 1 of identical households, as well as a large number of identical firms. Production takes place in two sectors which are heterogeneous with regards to productivity in that the economy features a high productivity sector, which constitutes the growth engine in the economy, as well as a low productivity sector.

3.1 Households

The representative household derives utility from consumption C_t and leisure $1-L_t$, where θ_t denotes the preference parameter of leisure as opposed to consumption.³ Consumption C_t is a Cobb-Douglas aggregate of the good produced in sectors h and l respectively:

$$C_t = (C_t^h)^\omega (C_t^l)^{1-\omega}, \quad (1)$$

where ω states the weight of the good in the high productivity sector ($0 < \omega < 1$). Households choose consumption of both goods C_t^h and C_t^l , labor input L_t as well as bond holdings B_{t+1} to maximize lifetime utility:

$$\max_{C_t^h, C_t^l, L_t, B_{t+1}} \sum_{t=0}^{\infty} \beta^t (\log(C_t) + \theta_t \log(1 - L_t)) \quad (2)$$

³Preferences are logarithmic, additive and separable in consumption and leisure as, for example, in King, Plosser and Rebelo (1989). The logarithmic structure of the preferences ensures the existence of a balanced growth path.

subject to the budget constraint

$$C_t^h + P_t^l C_t^l + \frac{B_{t+1}}{R_t} = W_t L_t + B_t + \Pi_t, \quad (3)$$

where $0 < \beta < 1$ denotes the subjective discount factor. P_t^l stands for the relative price of good l in terms of units of good h , the price of which is normalized to unity. Further, R_t represents the real interest rate and W_t the real wage expressed in good h units. B_{t+1} refers to the stock of one-period risk-free bonds, bought at the price $\frac{1}{R_t}$. We abstract from corner solutions and focus on equilibria in which production occurs in both sectors. Labor is perfectly mobile and wages equalize across sectors ($W_t^h = W_t^l = W_t$). Hence, $W_t L_t$ refers to the household's time t labor income. Firms are owned by the representative household which earns the corresponding firm profits Π_t .

The set of first order conditions can be derived as follows. The intratemporal condition links the relative price P_t^l to the marginal rate of substitution between good h and l respectively:

$$P_t^l = \frac{1 - \omega}{\omega} \frac{C_t^h}{C_t^l}. \quad (4)$$

The Euler equation, denoted in terms of C_t^h units, determines the intertemporal allocation of the consumption of the good produced in the high productivity sector and can be derived as

$$\frac{1}{C_t^h} = \beta R_t \frac{1}{C_{t+1}^h}. \quad (5)$$

Moreover, the trade-off between consumption and leisure can be stated as follows:

$$\frac{\theta_t}{1 - L_t} = \frac{\omega}{C_t^h} W_t. \quad (6)$$

3.2 Production: Low productivity sector

Contrary to sector h (see section 3.3), no technological innovations are realized in the low productivity sector l . This assumption captures the notion of sector h representing the growth engine in the economy, while at the same time keeping the model tractable.⁴ The non-tradable good is produced using labor by means of the production function

$$Y_t^l = L_t^l. \quad (7)$$

⁴For simplicity, I abstract from technological innovation in the low productivity sector. However, the key model implications would be qualitatively unaltered when allowing for productivity advances in both sectors while the learning-by-doing externality is more pronounced in the high productivity sector.

Firms in sector l choose labor input L_t^l to maximize profits

$$\max_{L_t^l} P_t^l Y_t^l - W_t L_t^l, \quad (8)$$

delivering the optimality condition

$$P_t^l = W_t. \quad (9)$$

3.3 Production: High productivity sector

Firms in the high productivity sector produce good h using labor input L_t^h and building on the stock of knowledge A_t according to the production function

$$Y_t^h = A_t (L_t^h)^{1-\alpha}, \quad (10)$$

where $0 < \alpha < 1$ and A_t is non-rival and non-excludable. Sector h can be considered the economy's growth engine as the evolution of knowledge A_t determines technological progress which constitutes the main driver of long-run growth in the economy. The costs of production in sector h consist of wage costs $W_t L_t^h$ as well as nonlinear hiring costs given by

$$A_t \frac{\psi}{2} \left(\frac{\Delta L_t^h}{L_{t-1}^h} \right)^2 L_{t-1}^h \mathbf{I}(\Delta L_t^h), \quad (11)$$

where

$$\mathbf{I}(\Delta L_t^h) = \begin{cases} 1, & \text{if } \Delta L_t^h > 0 \\ 0, & \text{otherwise} \end{cases} \quad (12)$$

and $\Delta L_t^h = L_t^h - L_{t-1}^h$ applies. The basic process describing the hiring costs is quadratic and standard as assumed in the literature on the adjustment cost of production factors. As described in equation, the indicator function $\mathbf{I}(\Delta L_t^h)$ equals unity in case of hiring ($L_t^h > L_{t-1}^h$) and zero otherwise, implying that labor adjustment costs are nonlinear and only occur in the case of hiring. Due to this property and the absence of adjustment costs in the low productivity sector, this specification also implies that labor can be hired freely into sector l , while hiring in the high productivity sector is subject to costs. This property seeks to capture the intuition that processes in the low productivity sector l are compared to the high productivity sector rather simplistic, rendering introducing newly hired workers in this sector to their tasks rapid and the training costs of new hires vis-à-vis the high productivity sector negligible. Hiring in sector h , in turn, is costly given the more complex production processes and correspondingly higher training costs of new hires. Put differently, the prevalence of hiring costs in the high productivity sector can also be interpreted as a tractable approximation of the presence of search and matching

frictions in the economy, thus reflecting the relatively higher search costs in the high productivity sector. ψ denotes a standard labor adjustment cost parameter. Hiring costs are indexed to the overall total factor productivity level in this sector A_t which ensures that the adjustment costs do not diminish as opposed to the wage costs given that real wages grow at the overall growth rate of the economy on the balanced growth path. In this setting, firms maximize profits by choosing the optimal labor allocation L_t^h

$$\max_{L_t^h} A_t (L_t^h)^{1-\alpha} - W_t L_t^h - A_t \frac{\psi}{2} \left(\frac{\Delta L_t^h}{L_{t-1}^h} \right)^2 L_{t-1}^h \mathbf{I}(\Delta L_t^h). \quad (13)$$

The corresponding optimality condition equals to

$$(1 - \alpha) A_t (L_t^h)^{-\alpha} - A_t \psi \left(\frac{\Delta L_t^h}{L_{t-1}^h} \right) \mathbf{I}(\Delta L_t^h) = W_t. \quad (14)$$

Since in the steady state labor allocation in sector h is constant, there are no adjustment costs on the balanced growth path ($\mathbf{I}(\Delta \bar{L}_t^h) = 0$). Hence, the optimality condition on the balanced growth path corresponds to $(1 - \alpha) (\bar{L}^h)^{-\alpha} = \frac{\bar{W}_t}{A_t}$.

3.4 Evolution of technology growth

The model economy is subject to endogenous growth in the stock of knowledge in sector h , implying the notion that sector h constitutes the growth engine in the economy. The underlying process of knowledge accumulation is of the form learning-by-doing in the sense that technological progress is increasing in labor allocated to the high productivity sector L_t^h . More specifically, the stock of knowledge A_t evolves according to the process

$$A_{t+1} = A_t (1 + \epsilon L_t^h d_t^k), \quad (15)$$

where $d_t = \frac{\bar{L}^h}{L_t^h}$ denotes the distance of the current labor allocation to the respective sector h employment on the balanced growth path \bar{L}^h . Hence, tomorrow's technology stock A_{t+1} depends positively on the current technology stock A_t and sector h labor L_t^h reflecting the fact that human capital is required for knowledge creation following Benigno and Fornaro (2014) and Alberola and Benigno (2017). The parameter ϵ captures the efficiency of sector h in knowledge accumulation ($\epsilon > 0$). Technology growth is moreover the higher, the larger the distance d_t to the labor allocation at the balanced growth path. This property increases the realism of the growth process by departing from a purely linear specification. Instead, the process of knowledge accumulation takes into account that any unit L_t^h can generate higher productivity advances when the labor allocation to the high productivity sector is below its steady state value and the economy is catching

up to its steady state. This assumption captures the notion that in this environment, any unit of labor allocated to sector h increases the technology stock more intensely than in an environment of relatively higher productivity. This features also the property of diminishing returns in the technological progress through R&D, as is in line with the empirical endogenous growth literature (see Griliches, 1990), stating that realizing technology advances becomes increasingly difficult when labor allocated to the innovative sector is already high. κ represents the weight of the distance to the productivity frontier, where $0 < \kappa < 1$ applies. From equation (15), the rate of technology growth g can be derived as

$$g_{t+1} = \frac{A_{t+1}}{A_t} = \epsilon L_t^h d_t^\kappa. \quad (16)$$

At the balanced growth path, the economy's rate of technology growth rate corresponds to $\bar{g} = \epsilon \bar{L}^h$ which implies that the long-run growth rate of the economy is increasing in the steady state labor allocation to the high productivity sector, reflecting the need of productive resources in realizing technology advances.

Importantly, and as demonstrated in detail in section (5.2), the knowledge accumulation process (15) generates a growth externality in the economy. Recall that the stock of knowledge is non-rival and non-excludable which implies in combination with the presence of a large number of firms in the high productivity sector that firms do not internalize the impact of their own labor allocation on the evolution of the economy's stock of knowledge. This property constitutes a growth externality since sector h firms do not internalize the social value of the labor allocated to the high productivity sectors in raising technology growth, aggregate productivity and thus the overall performance of the aggregate economy.

3.5 Competitive equilibrium

Let us now formulate the equilibrium conditions in the competitive equilibrium. Good markets for both good h and l have to clear:

$$C_t^h = Y_t^h, \quad (17)$$

$$C_t^l = Y_t^l. \quad (18)$$

As we consider a closed economy, bonds have to be in zero net supply:

$$B_t = 0. \quad (19)$$

Lastly, households' labor supply must be equal to the labor demand from firms:

$$L_t = L_t^h + L_t^l. \quad (20)$$

Hence, the perfect foresight equilibrium⁵ can be defined as a set of processes $\{Y_t^h, Y_t^l, L_t, L_t^h, L_t^l, C_t^h, C_t^l, P_t^l, A_{t+1}\}_{t=0}^{\infty}$ satisfying equation (4)-(7), (10), (15), (17), (18) and (20).

3.6 Calibration

This section presents the model calibration. The model is calibrated to annual frequency and the discount factor β is calibrated accordingly ($\beta = 0.975$). I calibrate the scale parameter in high productivity production α to $\frac{1}{3}$, as standard in the literature (see, for instance, Galí (2008)). The Cobb-Douglas aggregation parameter ω is set to 0.32 to generate a steady state share of high productivity to total employment $\frac{\bar{L}^h}{\bar{L}}$ of 0.24 - a value consistent with the share of high productivity sector employment in Germany over the observation period.⁶ Disutility of labor θ equals to 2.0146 in the initial state of the economy and to 1.7867 following the labor supply shock, generating overall employment levels of initially $\bar{L}_1 = 0.3072$ and $\bar{L}_2 = \frac{1}{3}$ in the post-shock phase. The efficiency of labor in the knowledge accumulation process ϵ is set to match an initial growth rate \bar{g}_1 of 1.47% and is hence in line with the average growth rate of the German economy over the post-reunification period up until the implementation of the large-scale labor market reforms in 2003. The hiring cost parameter ψ is set to a rather low value. To see that this holds true, consider the hiring costs in the case if high productivity firms would immediately fully increase employment in their sector to the new steady state value \bar{L}_2^h , then the hiring costs would correspond to less than one per cent of the wage bill in that sector. The parameter κ governs the relative weight of the distance of current labor allocation L_t^h to its steady state value and is set to 0.4. Further, given the other model parameters, the parameters ψ and κ jointly control the speed of the transition to the new steady state which corresponds to roughly 10 years in this setting.

⁵The underlying assumption on the nature of the labor supply shock is that it constitutes a one-time, unanticipated shock ("MIT shock").

⁶I define "high productivity sectors" as industry (excluding construction), information and communication, as well as financial and insurance services.

4 Wage and productivity dynamics

This section presents the effects of the employment shift on key economic variables with a special focus on the dynamics of real wages and productivity. Importantly, while the realized employment gains are associated with long-term improvements of most key economic variables (section 4.1), the rise in employment is in the initial phase of the transition to the new equilibrium accompanied by misallocation-induced slowdown of real wage and labor productivity growth, as well as by welfare losses (section 4.2). Section 4.3 discusses the general desirability of a shift to a high employment equilibrium in this context.

4.1 Long-run effects

This section presents the long-run effects of the employment shift. Table 2 compares the long-run economic outcomes in the initial steady state and in the steady state after the employment increase. The rise in employment is triggered by a labor supply shock in the form of a permanent fall in the disutility of labor θ from 2.0146 to 1.7867.⁷ This change induces a permanent increase in employment by 8.5 per cent to 0.33. Employment gains are realized in both sectors and, importantly, the economy settles in a new steady state in which the share of high productivity employment to total employment is equally high as in the pre-labor supply shock phase. The latter implies that the disproportionate allocation of productive resources caused by the shock presented in the subsequent section is only transitory and that the new long-run relative labor allocation is identical to the pre-shock steady state. This property implies that the increase in employment is not permanently associated with a higher degree of misallocation of labor to low productivity sectors. As highlighted in equation (15), the rate of technology growth depends positively on the labor allocated to the high productivity sector. As a result, the long-term increase in L^T translates into a higher rate of technology growth in the new long-run equilibrium. More specifically, at the new balanced growth path the rate of technology growth corresponds to 1.59% vis-à-vis 1.47% prior to the employment shift. Since labor productivity, defined as $\frac{Y_t^H + P_t^L Y_t^L}{L_t}$, grows at the rate of technology growth on the balanced growth path, also labor productivity grows correspondingly at an increased rate of 1.59% in the new long-run equilibrium. The long-run equilibrium interest rate R increases as a consequence of the surge in the economy's steady state growth rate ($1 + \bar{g} = \beta \bar{R}$).

As to the wage development, on the new balanced growth path real wages grow at the economy's new, higher equilibrium growth rate. Importantly though, and visible also

⁷The labor supply shock is assumed to constitute a one-time, unanticipated shock ("MIT shock").

	Initial steady state	Post-shock
θ	2.0146	1.7867
L	0.3072	0.3333
L^H	0.0733	0.0796
L^L	0.2338	0.2537
$\frac{L^H}{L}$	0.2388	0.2388
g	0.0147	0.0159
g_{LP}	0.0147	0.0159
R	1.0401	1.0420
$\frac{W}{A}$	1.5925	1.5498

Table 2: Initial and post-shock steady state allocation

from equation (14), the level of productivity-adjusted real wage $\frac{W_t}{A_t}$ drops permanently. This fall is caused by the standard channel of falling real wages following employment increases and the corresponding decrease in the marginal product of labor in the presence of diminishing returns in production.⁸

To summarize, the labor supply shift results in permanent increases in aggregate employment. Moreover, given increased employment in the high productivity sector, resources for technology growth increase, raising the overall rate of technology growth and thus the economy's equilibrium growth rate. As at the new balanced growth path real wages grow at the rate of technology growth, in the long-run the employment shift also exerts a positive impact on real wage growth. TFP-adjusted real wages $\frac{W_t}{A_t}$, however, fall permanently below their pre-employment shift value as a result of increased employment in the presence of diminishing returns in the high productivity sector.

4.2 Misallocation along the transition path

The long-run gains from the employment increases are not realized immediately in full but only gradually over time as the initial phase following the shift is characterized by a misallocation of labor to the low productivity sector l . Figure 2 illustrates the transitional dynamics to the new steady state following the labor supply shock.

As illustrated in the left uppermost panel, the employment increase is triggered by a permanent fall in the disutility of labor θ from 2.0146 to 1.7867 which can be interpreted as a decrease in individuals' outside option of working. This shift causes an increase of the labor supply and hence employment upon impact and further increases over the subse-

⁸The various underlying mechanisms are discussed in greater detail in the subsequent section.

quent periods until it reaches its new steady state value of 0.33 after about 10 periods. Concerning the relative labor allocation across sectors, initial employment increases are predominantly realized in the low productivity sector due to the presence of hiring costs in the high productivity sector. As firms in the low productivity sector do not face costs of hiring, sector l employment increases substantially upon impact, while the employment gains in the high productivity sector are initially small and increase only gradually to their new steady state value over time. As high productivity sector employment is prevented from equally absorbing the employment increases, the ratio of high productivity workers in total employment falls substantially relative to the initial steady state ratio.

The employment gains in the high productivity sector h foster knowledge accumulation as a result of increased resources in the learning-by-doing process (15) and hence raises the rate of technology growth g_t immediately in the initial phase following the transition. The growth rate of labor productivity, however, drops initially. This is the result of two channels. Firstly, in the presence of diminishing returns in sector h production, employment increases are accompanied by a fall in average productivity. Secondly, and most importantly, the positive impact of the increase of overall technology growth g_t on labor productivity is not proportional to the employment increase as a result of the misallocation of workers to the low productivity sector.

Over time, however, the drop in the share of high productivity sector employment in total employment begins to reverse due to gradual hiring in sector h as labor moves from the low to the high productivity sector. These employment gains in the high productivity sector raise resources for knowledge accumulation in the economy which translate into further increases in the rate of technology growth g_t . Improvements in technology growth also raises the growth rate of labor productivity g_t^{LP} . On its new balanced growth path, the transitory misallocation of productive resources is reversed and the ratio of high productivity labor in total employment returns to its pre-supply shock level.

The labor supply shift further exerts important effects on the development of real wages. Following the shift, real wages fall given employment gains given diminishing returns in production. When considering the productivity-adjusted real wage $\frac{W_t}{A_t}$, an initial fall is observable as a result of both the decline in the real wage W_t , as well as the increase in A_t resulting from employment gains in h . In the subsequent periods, real wages grow at a faster rate than technology growth, generating increases in the productivity-adjusted real wage $\frac{W_t}{A_t}$. However, on the new balanced growth path, productivity-adjusted real wages are permanently lower than in the initial steady state as a result of increased employ-

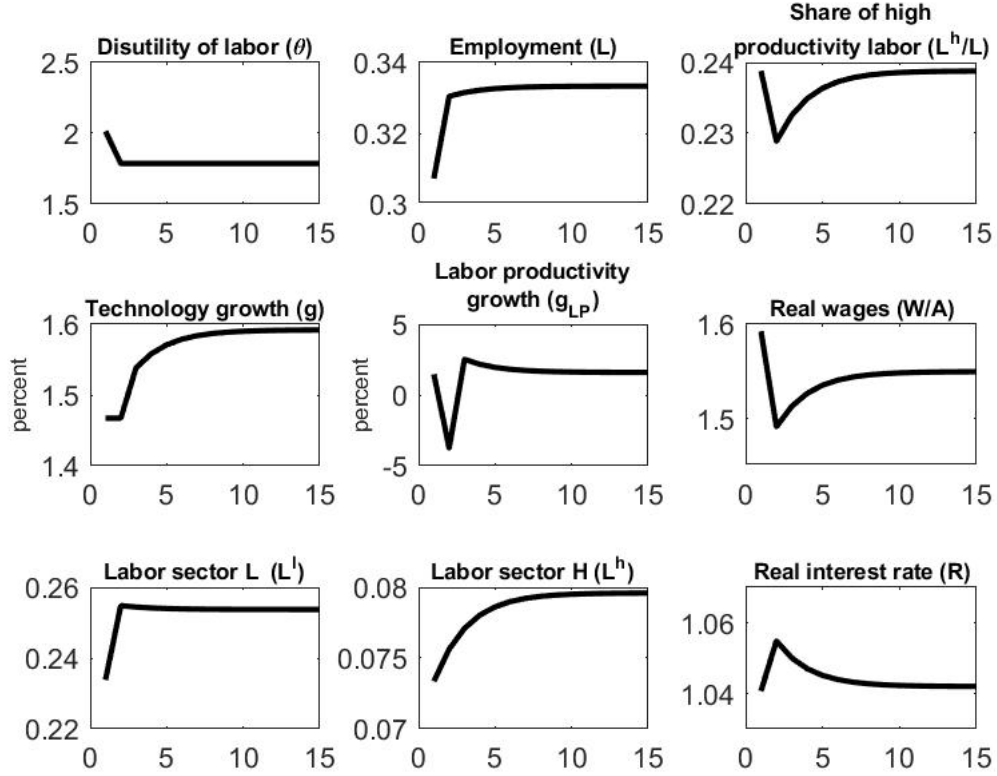


Figure 2: Transitional dynamics

ment under diminishing returns in high productivity production, as is also illustrated by equation (14). This permanent decline implies that the initial diversion of wage and productivity development is not made up for along the transition path. The growth rate of the real wage at the new balanced growth path regardless exceeds the pre-shock growth rate as real wages grow in the new equilibrium at the new, higher rate of technology growth.

The real interest rate R_t is higher at the new balanced growth path, as demonstrated in the previous section, but temporarily exceeds its new long-run value along the transition. This observation can be explained by agents' consumption smoothing motive: In the initial phase following the shock, output grows more strongly than at its equilibrium rate on the new balanced growth path as a result of both increases in technology growth and the rise in employment. As agents seek to smooth consumption, the real interest rate rises temporarily above its equilibrium level before it adjusts to its new equilibrium level.

4.3 Is shifting to a high employment steady state desirable?

The previous sections demonstrated that following the labor supply shock the economy realizes considerable employment gains. While these employment increases in itself constitute a desirable effect from a welfare perspective, the previously discussed findings suggest that the aggregate effect is not that clear-cut and that the balance of the effects depends also crucially on the considered horizon. The latter point is that while the transitory effect of the raise in employment is characterized by misallocation with the corresponding immediate negative effects on labor productivity and the evolution of real wages vis-à-vis productivity, the effects of moving to a high employment equilibrium over the long-term can be summarized as positive. In the long-run, the economy realizes a higher rate of technology growth and hence a higher aggregate growth rate on the new balanced growth path. Productivity-adjusted wages $\frac{W_t}{A_t}$ fall permanently short of their pre-shock levels as a result of the reduced average marginal product of labor given the realized employment increases, putting a wedge between total factor productivity and wages. Nonetheless, higher technology growth also translates into higher real wage growth in the new steady state, which implies that the benefits from the labor market shift are also passed on to workers in the form of higher real wage growth. Hence, in sum, despite its short- to medium-term adverse effects owed to the initial phase of misallocation, shifting to a high employment equilibrium can be evaluated as a desirable development given the positive effects on employment, technology growth and real wages growth on the new balanced growth path.

5 Inefficiency of the competitive equilibrium

The results presented in the previous section indicated that firms do not internalize the effect of their employment choices on the evolution of the stock of knowledge and ultimately on the long-run growth rate in the economy. Given the presence of this growth externality, the competitive allocation is not efficient. I demonstrate the inefficiency of the competitive equilibrium in what follows by deriving the social planner problem, its optimality conditions, as well as the resulting implications for the optimal resource allocation relative to the competitive equilibrium. Crucially, I find that relative to the social planner's choice, employment in the high productivity sector is inefficiently low in the decentralized economy, giving rise to the notion of resource misallocation in the competitive equilibrium.

5.1 Social planner problem

In contrast to the competitive equilibrium, the social planner takes directly into account the effect of its decisions on the evolution of the technology stock, aggregate productivity and the economy's long-run growth potential. In particular, the social planner's decisions factor in the additional aggregate income which can be generated by raising the production in the high productivity sector. The social planner chooses the variables $\{C_t^h, C_t^l, L_t^h, L_t^l, L_t, A_{t+1}\}$ to maximize households' expected utility subject to the resource constraints in the economy. More specifically, the social planner's problem can be stated as follows

$$\max_{C_t^h, C_t^l, L_t^h, L_t^l, L_t, A_{t+1}} \sum_{t=0}^{\infty} \beta^t (\log(C_t) + \theta_t \log(1 - L_t))$$

subject to the resource constraints

$$C_t^h = A_t (L_t^h)^{1-\alpha} - A_t \frac{\psi}{2} \left(\frac{\Delta L_t^h}{L_{t-1}^h} \right)^2 L_{t-1}^h \mathbf{I}(\Delta L_t^h),$$

$$C_t^l = L_t^l,$$

$$L_t = L_t^l + L_t^h,$$

as well as the process of knowledge accumulation

$$A_{t+1} = A_t (1 + h L_t^H d_t^\kappa).$$

Let us denote the Lagrange multipliers as λ^{C^h} , λ^{C^l} , λ^L and λ^A in the order of the stated constraints and the optimality conditions can be obtained as

$$\frac{\omega}{C_t^h} = \lambda_t^{C^h}, \quad (21)$$

$$\frac{1 - \omega}{C_t^l} = \lambda_t^{C^l}, \quad (22)$$

$$\frac{\theta_t}{1 - L_t} = \lambda_t^L, \quad (23)$$

$$A_t \left[\lambda_t^{C^h} \left((1 - \alpha) (L_t^h)^{-\alpha} - \psi \frac{\Delta L_t^h}{L_{t-1}^h} \mathbf{I}(\Delta L_t^h) \right) \right] + A_t \lambda_t^A \epsilon (1 - \kappa) d_t^\kappa = \lambda_t^L, \quad (24)$$

$$\lambda_t^{C^l} = \lambda_t^L, \quad (25)$$

$$\lambda_t^A = \beta \lambda_{t+1}^{C^h} \left[(L_{t+1}^h)^{1-\alpha} - \frac{\psi}{2} \left(\frac{\Delta L_{t+1}^h}{L_t^h} \right)^2 L_t^h \mathbf{I}(\Delta L_{t+1}^h) \right] + \beta \lambda_{t+1}^A (1 + h L_{t+1}^h d_{t+1}^\kappa). \quad (26)$$

Let us now turn to the impact of an employment shift in the social planner equilibrium. Figure 3 demonstrates the effect of a labor supply shock on the key economic variables in the social planner allocation as opposed to the competitive equilibrium. We can observe the following central differences in the social planner equilibrium. Firstly, while the labor supply shock is set to equal size in both economies, employment in the social planner economy total employment increases by more than in the competitive equilibrium. Additionally, the social planner allocates substantially more labor to the high productivity sector throughout the transition to the new balanced growth path. Importantly, the initial drop in employment in the high productivity sector versus the low productivity sector is by far less pronounced in the social planner equilibrium. Moreover, the transition time to the new steady state is markedly reduced as the social planner seeks to alleviate the misallocation of productive resources alongside the transition path. Lastly, the social planner also raises the total share of labor allocated to the high versus low productivity sector at the new balanced growth path. All these observations reflect the social planner's awareness of the impact of its employment choices on the rate of technology growth, aggregate productivity and ultimately the economy's long run growth potential. This is strongly reflected in the evolution of technology growth: By choosing a higher aggregate employment level and hence allocating overall more productive resources to production, as well as by allocating an increased share of total employment to the economy's growth engine, the social planner realizes substantially higher rates of technology growth and thus long-run growth vis-à-vis the competitive equilibrium. This property emphasizes also the fact that the initial disproportional employment gains in the low-growth sector are inefficient and can hence constitute a form of resource misallocation.

5.2 The role of the growth externality

This section demonstrates analytically the mechanisms driving the wedge between the allocation in the social planner's problem and the decentralized economy and shows that the presence of a growth externality resulting from the process of knowledge accumulation (15) is key in generating the inefficiency in the competitive equilibrium. To understand the role of the growth externality in this context, combine equations (24) and (25) to obtain a condition determining the relative allocation of labor across sectors in the economy

$$A_t \left[(1 - \alpha) (L_t^h)^{-\alpha} - \psi \frac{\Delta L_t^H}{L_{t-1}^h} \mathbf{I}(\Delta L_t^h) \right] + \underbrace{A_t \frac{\lambda_t^A}{\lambda_t^{C^h}} \epsilon (1 - \kappa) d_t^\kappa}_{\text{growth externality}} = \frac{\lambda_t^{C^l}}{\lambda_t^{C^h}}.$$

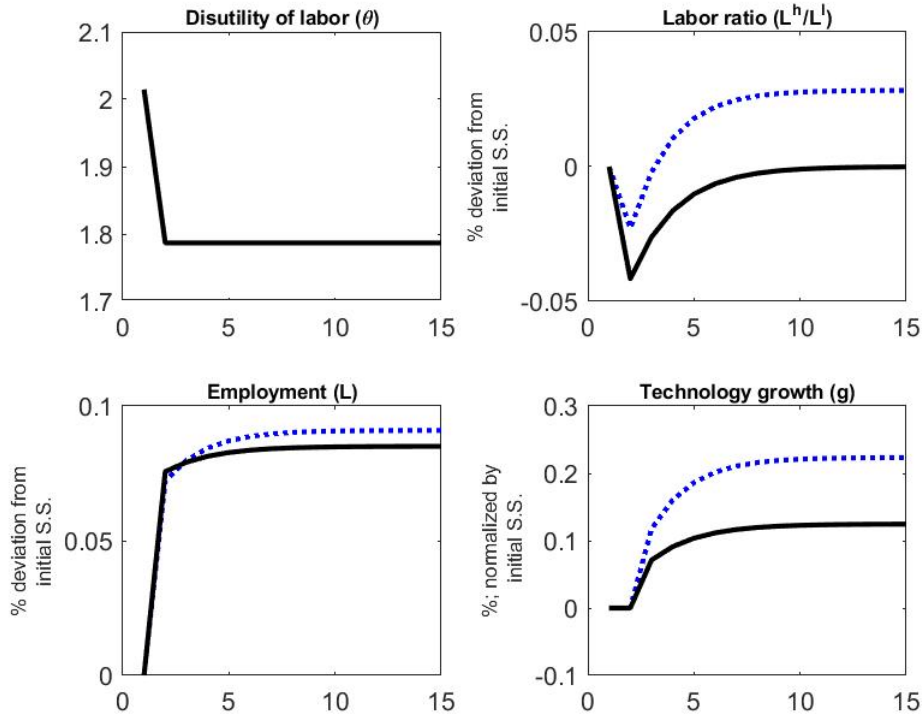


Figure 3: Transitional dynamics

Black solid lines: dynamics in the decentralized economy; blue dotted lines: dynamics in the social planner economy; aggregate employment L_t and the employment ratio $\frac{L_t^h}{L_t}$ are denoted in terms of percentage deviations from the initial, i.e. pre-supply shock steady state allocation; the rate of technology growth g_t is normalized by the growth rate at the initial balanced growth path \bar{g}^1 and the transition graph hence depicts the percentage point increase in the technology growth rate relative to the initial balanced growth path $g_t - \bar{g}^1$.

In the absence of a growth externality ($\epsilon = 0$), the labor allocation to the high growth sector does not exert any effect on technology growth and the social planner equilibrium and the competitive equilibrium coincide. To see that this holds true, consider the case $\epsilon = 0$. Then, just as in the competitive equilibrium, the growth externality would not play a role in the social planner allocation and the previously stated condition would correspond to

$$A_t \left[(1 - \alpha) (L_t^h)^{-\alpha} - \psi \frac{\Delta L_t^H}{L_{t-1}^h} \mathbf{I}(\Delta L_t^h) \right] = \frac{\lambda_t^{C^l}}{\lambda_t^{C^h}}.$$

To see how this links to the allocation in the competitive equilibrium, recall that in the decentralized economy $W_t = P_t^l$ applies and combined with equation (14) one can obtain $A_t \left[(1 - \alpha) (L_t^h)^{-\alpha} - \psi \frac{\Delta L_t^H}{L_{t-1}^h} \mathbf{I}(\Delta L_t^h) \right] = P_t^l$. As the relative price P_t^l in the competitive equilibrium can be understood as the ratio of shadow prices $\left(P_t^l = \left(\frac{\lambda_t^{C^l}}{\lambda_t^{C^h}} \right)_{CE} \right)$, it follows straightforwardly $\left(\frac{\lambda_t^{C^l}}{\lambda_t^{C^h}} \right)_{SP} > \left(\frac{\lambda_t^{C^l}}{\lambda_t^{C^h}} \right)_{CE}$ for $\epsilon > 0$. This holds true as the social planner takes into account in its decision making the effect of the labor allocation to the high productivity sector on technology growth via the growth externality. As from equations (21) and (22) follows that the relative consumption and hence labor allocation in sector h as opposed to sector l is increasing in the ratio $\left(\frac{\lambda_t^{C^l}}{\lambda_t^{C^h}} \right)$, the social planner allocates a relatively higher share of labor to the high productivity sector as a result of its effect on the economy's growth performance:⁹

$$\left(\frac{L_t^h}{L_t^l} \right)_{SP} > \left(\frac{L_t^h}{L_t^l} \right)_{CE}.$$

While this implies a relatively higher share of employment in the high productivity sector versus the low productivity in the steady state, this result has also important implications for the transition to the new steady state as the social planner eliminates the distortively low relative labor allocation to the high productivity sector. This findings also shows that the initial disproportionately low allocation to sector h constitutes a misallocation of productive resources in the economy. Note also that, generally, the effect of the growth externality on resource allocation in the social planner problem is the stronger, the higher the Lagrange multiplier λ_t^A which denotes, as stated in equation (26), the value the social planner attributes to raising productivity in the economy.

In addition to raising the ratio of high productivity to low productivity employment $\frac{L_t^h}{L_t^l}$ and given the endogeneity of the labor supply, the social planner raises sector h employment

⁹Technically this holds true as $A_t \lambda_t^A \epsilon (1 - \kappa) d_t^\epsilon > 0$.

also by increasing total employment L_t :

$$(L_t)_{SP} > (L_t)_{CE}.$$

Appendix (A.1) provides a formal proof for higher overall employment in the social planner equilibrium. Lastly, while the misallocation along the transition path is the main focus of this analysis, note that these findings also imply an inefficiently low labor allocation to the high productivity sector on the balanced growth path in the decentralized economy which implies an inefficient degree of technology growth in the steady state. This is in line with a feature frequently prevalent in standard endogenous growth models, namely an inefficiently low overall level of technology-enhancing investment in the competitive equilibrium (Romer, 1990).

6 Policy implications

The previous sections have demonstrated the effects of the employment shift on key economic variables. This section discusses the implications of these findings for macroeconomic policy with a special focus on potential complementary policy strategies to alleviate the resulting inefficiencies given the misallocation along the transition path. Section 6.1 shows how the social planner allocation can be decentralized in the competitive equilibrium and by that demonstrates the main properties characterizing optimal policy intervention in this context. Section 6.2 presents policy strategies which are in line with the previously derived options for decentralizing the competitive equilibrium.

6.1 Decentralizing the social planner allocation

This section addresses how the social planner allocation can be decentralized in the competitive equilibrium. A potential policy option to impose the social planner's choice in the competitive equilibrium is subsidizing production in the high productivity sector h , which is demonstrated in what follows. Firstly, recall that the optimality condition in the social planner equilibrium which internalizes the effect of the labor allocation on the overall rate of technology growth in the economy equals to

$$A_t \left[(1 - \alpha) (L_t^h)^{-\alpha} - \psi \frac{\Delta L_t^h}{L_{t-1}^h} \mathbf{I}(\Delta L_t^h) \right] + A_t \frac{\lambda_t^A}{\lambda_t^{C^h}} \epsilon (1 - \kappa) d_t^\kappa = \frac{\lambda_t^{C^l}}{\lambda_t^{C^h}}.$$

Note further that in the competitive equilibrium with subsidies to production in the high productivity sector τ_t - financed by lump sum taxes T_t on households, firms maximize profits Π_t^h as described as follows:

$$\max_{L_t^h} \Pi_t^h = (1 + \tau_t) A_t (L_t^h)^{1-\alpha} - W_t L_t^h - A_t \frac{\psi}{2} \left(\frac{\Delta L_t^H}{L_{t-1}^H} \right)^2 L_{t-1}^H \mathbf{I}(\Delta L_t^h),$$

which delivers the optimality condition in the presence of subsidies:¹⁰

$$(1 + \tau_t)(1 - \alpha) A_t (L_t^h)^{-\alpha} - A_t \psi \frac{\Delta L_t^H}{L_{t-1}^H} \mathbf{I}(\Delta L_t^h) = P_t^l.$$

Since $\frac{\lambda_t^{C^l}}{\lambda_t^{C^h}} = P_t^l$ applies, we can derive the condition for the optimal subsidy by equating the left-hand side of the optimality conditions in the social planner and competitive equilibrium respectively as:

$$\tau_t = \frac{\frac{\lambda_t^A}{\lambda_t^{C^h}} \epsilon (1 - \kappa) (d_t)^\kappa}{(1 - \alpha) (L_t^h)^{-\alpha}}.$$

Hence, the optimal subsidy displays the following properties. Firstly, in the absence of the growth externality ($\epsilon = 0$), the optimal subsidy is zero as the allocation in the decentralized and social planner equilibrium allocation. Crucially, the stronger the externality in the knowledge accumulation process, i.e. the higher ϵ , the efficiency parameter of sector h labor allocation in generating technology advances, the higher the optimal subsidy to high productivity production. The underlying reason is that the aggregate resources the social planner can generate by allocating labor to the high productivity sector are the larger, the stronger the externality as any additional unit of labor allocated to sector h will more strongly impact on the speed of knowledge accumulation and hence both aggregate growth and income. Importantly, the subsidy is also increasing in the distance to the productivity frontier d_t . Consequently, on the transition path to the new balanced growth path, the subsidy will be higher vis-à-vis its steady state level as the social planner intends to increase the speed of convergence to the new high employment-high productivity growth equilibrium. It is worth noting that, nevertheless, the subsidy is non-zero also at the balanced growth path, indicating once more the inefficiently low labor allocation to the economy's growing sector h in the decentralized economy. This effect is the stronger the higher is the relative weight on high productivity labor L_t^h in knowledge generation versus the distance to the frontier, i.e. the lower κ .

We can now derive the tax corresponding to the optimal subsidy. As stated before,

¹⁰The optimality condition in the low productivity sector $P_t = W_t$ is also imposed in this step.

the subsidy is financed via lump sum taxation on households implying that household's decisions are left unaltered in equilibrium. The corresponding lump sum tax on households can be derived as $T_t = \tau_t y_t^h$ and thus as $T_t = \tau_t A_t (L_t^h)^{1-\alpha}$ which equals to:

$$T_t = \frac{\lambda_t^A}{\lambda_t^{C^h}} \frac{\epsilon(1-\kappa)}{1-\alpha} d_t^\kappa A_t L_t^h.$$

Lastly, the household budget constraint in the competitive equilibrium with subsidies to production in the high productivity sector corresponds to $C_t^h + P_t^l C_t^l + \frac{B_{t+1}}{R_t} = W_t L_t + B_t + \Pi_t - T_t$.

6.2 Options for policy

Based on the theoretical analysis, we can conclude that shocks which raise the labor supply and hence employment will at first be accompanied by a transitional episode in which economic variables adjust towards the new steady state. This transitory phase, however, is characterized by a misallocation of production factors to the low productivity sector and a deceleration of labor productivity and real wage growth. As demonstrated in the previous section, the social planner equilibrium can be decentralized by subsidizing production in the high-growth sector. Consequently, sector h production subsidies constitute apt policy tools in alleviating the inefficiencies along the transition path. Hence, in practice, in the case of a positive labor supply shock, policy makers should in the direct aftermaths temporarily subsidize the production in the high productivity sectors, i.e. in those economic segments which constitute the growth engines in the economy. By doing so, economic policy can avoid that employment gains are disproportionally realized in low-growth sectors with the concomitant adverse effects on the evolution of technology growth, labor productivity and real wages, emphasizing the active role accruing to policy making in this context. As a result, labor market reforms aimed at raising employment should be optimally paired with policies which promotes job growth not only in low productivity areas but especially so in those economic sectors which are essential in promoting productivity growth. More specifically, the ultimate goal post for optimal labor market policies from a welfare perspective constitutes not only - while important in itself - realized employment increases but instead also the quality of employment gains in terms of their contribution to the evolution of aggregate productivity. If policy takes the impact on productivity actively into account, it can positively affect the economy's medium-term productivity performance and the rate of the technology growth over this horizon, as well as speed up the transition to the new high employment-high growth steady state and alleviate the corresponding welfare losses. Moreover, given the role of the hiring costs in governing

the duration of the initial misallocation, it should also be a priority for policy making to reduce these costs of labor adjustment to high productivity sectors by fostering the flow of labor to these sectors. More specifically, supporting workers' education and retraining in lower productivity sectors supports the transformation from low into high productivity employment by reducing firms' corresponding costs of hiring and thus the duration of the employment transition with a positive effect on productivity and real wage growth.

7 Conclusions

Recent experience of several advanced economies has been characterized by a sustained slowdown in productivity as well as stagnant real wage growth while simultaneously undergoing upward-shifts in employment - triggered for instance by labor market reforms. Drawing on this observation, I propose a mechanism which demonstrates that the phenomena of stagnant real wages and slowing productivity can constitute two sides of the same coin resulting from the employment shift in this context and follow from an initial misallocation of labor to low productivity sectors in the event of an employment expansion. For that purpose, I derive a nonlinear two-sector endogenous growth model where productivity is heterogeneous across sectors and technology growth is concentrated in the high productivity sector which represents the growth engine in the economy. The model features an endogenous total factor productivity mechanism in the form of learning-by-doing in which technological progress is increasing in the labor allocated to the high-growth sector. Labor is generally homogeneous and mobile across sectors but nonlinear adjustment costs in the high productivity sector prevent the instantaneous transition of labor to this sector.

I demonstrate by means of this model that the employment expansion is desirable as it raises technology and productivity growth while also fostering the growth of real wages over the long-term. In the short- to medium-run, by contrast, productivity and real wage growth undergo a phase of stagnation. My analysis illustrates that given the growth externality resulting from the learning-by-doing process in the high productivity sector, the competitive allocation is not efficient as firms in this sector do not internalize the impact of their own labor allocation choice on the performance and welfare of the aggregate economy. Moreover, the inefficiencies in the competitive equilibrium call for policy intervention: I prove that subsidies to high productivity sector production constitute an apt policy tool to alleviate the initial degree of misallocation in the aftermath of the employment shock. By means of these subsidies welfare losses on the transition path to the new high-employment - high growth equilibrium can be alleviated - highlighting also the

importance of not only the quantity but also the quality of employment in evaluating the recent slowdown in productivity and real wage growth.

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A Appendix

A.1 Social planner equilibrium: Steady state allocation

As outlined in section (5.2), the social planner would allocate more labor to the high productivity sector by both raising the ratio of high productivity to low productivity employment ($\frac{L_t^h}{L_t^l}$) and increasing total employment L_t in the economy. Section 5.2 showed why the relative labor allocation is higher in the social planner equilibrium. This section delivers the underlying mechanism why overall employment in the social planner's choice exceeds its counterpart in the competitive equilibrium. To see that it holds true that the social planner would raise total employment relative to the competitive allocation, combine equation (22), (23) and (25) to obtain

$$\frac{\theta_t}{1 - L_t} = \frac{1 - \omega}{C_t^l}$$

which in turn, using the goods market clearing condition for sector l ($C_t^l = L_t^l$), delivers a condition for L_t^l :

$$L_t^l = \frac{1 - \omega}{\theta_t} (1 - L_t). \quad (27)$$

Based on the latter equality with the labor market clearing condition $L_t = L_t^h + L_t^l$, the following expression for L_t^h can be derived:

$$L_t^h = L_t \left(1 + \frac{1 - \omega}{\theta_t} \right) - \frac{1 - \omega}{\theta_t}. \quad (28)$$

The ratio $\frac{\lambda_t^{C^l}}{\lambda_t^{C^h}}$ can be obtained by combining equation (21) and (22) as $\frac{\lambda_t^{C^l}}{\lambda_t^{C^h}} = \frac{1 - \omega}{\omega} \frac{C_t^h}{C_t^l}$. From combining this equality further with the goods market clearing conditions and the respective production functions in both sectors follows

$$\frac{\lambda_t^{C^l}}{\lambda_t^{C^h}} = \frac{1 - \omega}{\omega} \frac{A_t (L_t^h)^{1 - \alpha}}{L_t^l}. \quad (29)$$

In combination with the previously derived equation (27) and (28), we receive an expression for $\frac{\lambda_t^{C^l}}{A_t \lambda_t^{C^h}}$:

$$\frac{\lambda_t^{C^l}}{A_t \lambda_t^{C^h}} = \frac{1 - \omega}{\omega} \frac{\left(L_t \left(1 + \frac{1 - \omega}{\theta_t} \right) - \frac{1 - \omega}{\theta_t} \right)^{1 - \alpha}}{\frac{1 - \omega}{\theta_t} (1 - L_t)}. \quad (30)$$

As demonstrated in the previous proof, due to the presence of the growth externality in the economy, $\left(\frac{\lambda_t^{C^l}}{A_t \lambda_t^{C^h}} \right)_{SP} > \left(\frac{\lambda_t^{C^l}}{A_t \lambda_t^{C^h}} \right)_{CE}$ applies, stating that the relative labor allocation

$\frac{L_t^h}{L_t^l}$ is higher in the social planner equilibrium since the social planner internalizes the effect which sector h employment exerts on aggregate growth. Condition (30) demonstrates that this property also coincides with an increase in the overall labor allocation in the economy L_t . To see why this is the case, note that the proof in section (4.2) demonstrated that $\left(\frac{\lambda_t^{C^l}}{A_t \lambda_t^{C^h}}\right)_{SP} > \left(\frac{\lambda_t^{C^l}}{A_t \lambda_t^{C^h}}\right)_{CE}$. As L_t constitutes the only variable on the right hand-side of equation (30), an increase in the left-hand side has to be brought about by an increase in L_t .¹¹ Hence, as a result, the social planner allocation is also subject to a higher overall employment level than is the case in the competitive equilibrium:

$$(L_t)_{SP} > (L_t)_{CE} . \blacksquare$$

¹¹The sign of the change in L_t has to be positive as the right-hand side of equation (30) is increasing in L_t .