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Effects of North–South trade on wage inequality and on human-capital accumulation

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ABSTRACT

This paper develops an endogenous growth model with technological knowledge directed towards high- versus low-skilled labour, augmented with North–South international trade of intermediate goods and with human-capital accumulation, to analyse how trade affects wage inequality and the inter-country human-capital gap. Trade is a vehicle for inter-country technological-knowledge diffusion and human-capital accumulation interacts with the intra-country direction of technological knowledge arising from trade. In contrast with the market-size effect, stressed in the skill-biased technological change literature, the operation of the price channel following openness to trade predicts, in line with the recent trends in developed and developing countries, an increasing technological-knowledge bias towards high-skilled human capital. This, in turn, decreases inter-country gaps of technological knowledge and human capital and increases intra-country wage inequality. Also in line with recent empirical evidence, inter-country wage convergence is induced by the trade-opening level effect.

1. Introduction

Empirical evidence detects two compelling trends since the early 1980s: (i) rise in wage inequality in favour of high-skilled labour and (ii) rise in the proportion of high-skilled labour, both occurring in developed (North) and developing (South, newly-industrialized) countries, in the context of strong technological-knowledge progress and enlarged intermediate goods trade flows (e.g., Acemoglu, 2003; Avalos and Savvides, 2006; Berman et al., 1998; Egger and Kreickemeier, 2008; Goldberg and Pavcnik, 2007; Machin and Van Reenen, 1998; Robertson, 2004; Zhu and Trefler, 2005). To account for the above empirical facts, we develop an endogenous directed technological-knowledge model with North–South trade and human-capital accumulation. In the model, trade of intermediate goods is a vehicle for inter-country technological-knowledge diffusion and human-capital accumulation interacts with the intra-country direction of technological knowledge arising from trade.

The two main approaches in the literature contradict at least one of the mentioned trends. The dominant trade approach (e.g., Leamer, 1998; Wood, 1995) relies on the labour-level channel through the Stolper–Samuelson theorem; i.e., a decline in the relative price of the imported good reduces the return of the factor that is used intensively in its production; however, applied to the South, it would predict a reduction of the high-skilled labour premium. The technological approach (e.g., Acemoglu, 1998, 2002; Acemoglu and Zilibotti, 2001) relies on the market-size channel; i.e., larger high-skilled labour creates a larger demand for R&D biased towards improvements in inputs used in goods produced by high-skilled labour, thus increasing relative high-skilled wages; however, applied to trade with the South (low-skilled abundant), it would predict a reduction of the high-skilled technological-knowledge bias and, thus, of the high-skilled premium in the North.

Thus, in these two approaches labour levels govern wage inequality, either in a Heckscher–Ohlian way or through R&D intensity. However, with respect to the latter, and in addition to the described market-size channel, the direction of R&D is also influenced by the price of goods (price channel), since more expensive goods command higher profits for the producers of the respective inputs. For instance, the relative abundance of high-skilled labour increases the competitive price of goods produced by low-skilled labour and, thus, the demand for R&D directed towards improvements in goods produced by low-skilled labour.

Pursuing this argument, we merge the technological and the trade approaches, by shifting the focus to the price channel (instead of the market size) (e.g., Afonso, 2006, 2008) and by accounting for technological-knowledge diffusion (e.g., Barro and Sala-i-Martin, 1997; Grossman and Helpman, 1991), which we deem as non-dissociable from intermediate-good trade (e.g., Amiti and Konings, 2007; Goldberg et al., 2008). This framework then implies that when the high-skilled labour abundant North exports inputs incorporating its R&D results to a low-skilled abundant South, it benefits from the higher prices of

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goods produced by high-skilled labour in the South. The resulting profit opportunities redirect R&D towards inputs that increase the marginal productivity and thus wages of high-skilled labour in the North and, under technological-knowledge diffusion, in the South.

Furthermore, instead of fixed labour levels, we consider endogenous human-capital accumulation, through both schooling and on-the-job-training (OJT), in line with Lucas (1993) and Mincer (1993). Indeed, most of the empirical evidence points out the complementary nature of schooling and OJT (e.g., Bartel and Litchtenberg, 1987; Brunello, 2004; OECD, 2001). In particular, high complementarity means that schooling is far from providing all the needed skills, which supports the claims in the growth-human-capital literature that the lack of an empirically robust relationship between human capital and growth is partially caused by the exclusion of OJT (e.g., Lucas, 1993). We assume that, relative to low-skilled, high-skilled human capital is school intensive and is more efficient in production.

Final-goods production uses low (or high)-skilled human capital together with low (or high)-specific quality-adjusted intermediate goods (e.g., Acemoglu and Zilibotti, 2001). Innovative Northern R&D improves the quality of intermediate goods — Schumpeterian R&D, as formalized by Aghion and Howitt (1992). The South has a marginal cost advantage in final-goods production and R&D results are imitations of Northern innovations — as in Grossman and Helpman (1991, chs. 11 and 12). In order to focus on the price-channel mechanism, we remove scale effects as suggested by the dominant related literature (e.g., Barro and Sala-i-Martin, 2004, ch. 7; Jones, 1995a,b).

Upon trade opening, human-capital accumulation responds to incentives arising from technological-knowledge diffusion. Due to the immediate access by the South to the technological knowledge embodied in the intermediate goods produced in the North (level effect), wages jump upwards in South. Facing the permanent increase in wages, Southern individuals adjust time allocation, devoting more time to human-capital accumulation of both types along transition. Thus, trade induces inter-country human-capital level convergence.

On the other hand, the North–South average relative price of final goods produced by high-skilled human capital is always higher than the one prevailing in pre-trade North. Thus, through the price channel, trade redirects technological knowledge in favour of intermediate goods used with high-skilled human capital, which relatively increases wages of high-skilled workers (high-skilled worker premium; i.e., the relative wage per worker who accumulates high-skilled human capital) in both countries. This then relatively improves the accumulation of high-skilled human capital, thereby increasing its relative supply.

Human-capital supply affects wage inequality such that high-skilled worker premium rises even if the high-skilled human capital premium (i.e., the relative wage of high-skilled per unit of human capital) drops, due to the relative rise of high-skilled human capital per worker. Comparative dynamics shows that intra-country high-skilled human capital premium is more likely to prevail under trade when the world accumulation of the Southern relatively abundant type of human capital is enhanced and/or the absolute advantage of high-skilled human capital in final-goods production is improved.

Our paper seeks to contribute to a revived literature on trade and wage inequality (e.g., Davidson et al., 2008; Egger and Kreickemeier, 2008; Helpman et al., 2008; Thoenig and Verdier, 2003; Yeaple, 2005; Zeira, 2007). In particular, our results relate closely to Helpman et al. (2008), Thoenig and Verdier (2003) and Zeira (2007), in as much as the analysis is consistent with empirical findings of increased wage inequality in both developed and developing countries following trade liberalization. However, our model is the only one that brings together human-capital accumulation, technological-knowledge progress (Northern innovation and Southern imitation, induced by the price channel) and inter-country technological-knowledge diffusion through trade. The path followed by prices is supported by empirical studies such as Broda and Romalis (2009) and Krueger (1997).

The paper now proceeds to characterise the economic structure and the international market. In Section 3 we analyse the dynamic general equilibrium, we obtain the level, steady-state and transitional dynamics price-channel effects of trade, and we analyse the comparative statics and dynamics resulting from alternative parameters of human-capital accumulation and of final-goods production. In Section 4 we present some concluding remarks.

2. Economic structure

By expanding the closed-economy endogenous R&D-growth model with fixed labour levels proposed by Afonso (2006, 2008), we define the productive setup, which, excluding some parameter values and some elements of R&D activities, is common to both countries.

Each economy is populated by infinitely-lived individuals and population growth is zero. Individuals choose between consumption and savings on income allocation and between production and human-capital accumulation on time allocation.

Competitive final goods use low (or high)-skilled human capital together with low (or high)-specific quality-adjusted intermediate goods. Quality-adjusted intermediate goods are produced under monopolistic competition by combining units of aggregate output and designs (e.g., Aghion and Howitt, 1992). Designs are obtained through R&D – Northern innovative and Southern imitative – which affect technological knowledge, economic growth and wages.

2.1. Households

A time-invariant number of heterogeneous individuals decide the allocation of income and time. Income is partly spent on consumption of aggregate final output, Y, and partly lent in return for future interest. Time, t, is divided between human-capital accumulation, and working to earn a share of Y proportional to the individual's human capital.

Heterogeneity is present in two connected individuals' features: the ability level, a, uniformly distributed over a range [0, 1], and the human-capital type. We consider a threshold ability $\bar{a}$, such that high ability individuals, $a > \bar{a}$, accumulate high-skilled human capital, H, and low ability individuals, $a \leq \bar{a}$, are only able to accumulate low-skilled human capital, L. Individuals have identical preferences described by a stable relative risk aversion lifetime utility function $\int_0^\infty \frac{c_a(t)^{1-\theta}-1}{1-\theta}\exp(-\rho t)dt$; where $c_a(t)$ is the level of consumption of Y of individual a at t, $\rho > 0$ is the subjective discount rate and $\theta > 0$ is the relative risk aversion.

Savings are the accumulation of financial assets, K, which have return (the interest rate) r.[1] The budget constraint of a at t equalises savings to income earned minus consumption: $\dot{K}_a(t) = r(t)K_a(t) + \left[1-u_{F,a}(t)-u_{T,a}(t)\right]w_m(t)m_a(t)-c_a(t)$, where: m indexes the human capital type;[2] $w_m(t)$ is the wage per unit of m-type human capital at t; and $u_{F,a}(t)$ and $u_{T,a}(t)$ are the fractions of t that a spends at school and on-the-job-training (OJT),[3] respectively; due to arbitrage in the domestic assets markets, r depends neither on a nor on m, only on t.

Individuals accumulate either H or L, restricted by the ability level, using schooling and OJT. The productivity of the time spent increases

[1] That is, lending takes the form of ownership of profitable firms, which are the ones that produce quality-adjusted intermediate goods. The value of these firms, in turn, is the value of patents in use.

[2] That is, $m_a = L_a$ ($m_a = H_a$), if $a \leq \bar{a}$ ($a > \bar{a}$), and $L = \int_0^{\bar{a}} L_a da$ $\left(H = \int_{\bar{a}}^1 H_a da\right)$.

[3] Following Mincer (1993), we consider that OJT is costly, in the sense that it requires time away from work.