Who gains from offshoring in a dynamic product cycle model?

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Abstract

In this paper I analyze income inequality in a dynamic North-South model with endogenous offshoring, innovation and imitation. I find that offshoring affects the skill premium via more channels than in static models. More precisely, I identify a profit discounting effect as well as long-run composition effect and a spillover effect which depend on the endogenous share of Northern and Southern varieties. They can possibly reverse well-known static wage effects from offshoring.

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1 Introduction

Explaining the patterns of wages across countries and time is one of the important challenges for modern economics, so that troublesome trends in income distribution may be analyzed and mitigated. The crucial role of a country's endowments for its factor prices is reduced when countries open up to trade. Indeed, the factor price equalization theorem tells us that under certain conditions all countries' factor prices are determined by the world endowment. According to this logic, trade does away with *scarcity premia* earned by owners of a country's scarce resources, and the factor content of trade should tell us what openness does to a country's factor prices.[1]

This logic turns inaccurate when accounting for other aspects of international integration. A recent trend is the advent of international fragmentation of production chains, also called offshoring.[2] Models of offshoring usually require that production may be sliced into tiny components or tasks, that differ with respect to their skill intensity or offshoring costs. Theoretical studies on the effects of offshoring on factor prices give mixed results. Most prominent example are probably Feenstra & Hanson (1997) who use a one-sector model to show that offshoring may increase skill premia in both countries that start to engage in bilateral offshoring. Arndt (1997) uses a two-sector framework to demonstrate that workers may gain, even if labour-intensive activities are being offshored. More recently, Grossman & Rossi-Hansberg (2008) decompose wage effects from offshoring into three components: a productivity effect, a relative price effect, and a labor supply effect. They show that the productivity effect works in favor of low-skilled labor and is big for an advanced degree of offshoring. The relative price effect and the labor supply effect usually work in favor of the high-skilled, when low-skilled labor is subject to offshoring. Other contributions include Venables (1999), Egger & Falkinger (2003), Kohler (2003), and Egger & Kreickemeier (2005). Focusing on developing countries, Trefler & Zhu (2005) point to a systematic effect towards increasing their skill premium from developed countries' catching-up in terms of income. Benz & Kohler (2011) show that even offshoring between countries with identical relative endowments may drive up the skill premium. The

[1] See the discussion in Deardorff (2000), Krugman (2000), Leamer (2000), and Panagariya (2000).

[2] Empirical evidence on the magnitude and growth of offshoring can be found in Hummels *et al.* (2001), Yeats (2001), and Yi (2003).

empirical literature is even less clear cut. Lawrence & Slaughter (1993) and Berman *et al.* (1994) find that offshoring does not contribute much to changes in US wages. Feenstra & Hanson (1999) estimate that offshoring explains about 15% of the increasing relative wage of nonproduction workers. Other explanations, such as biased technological change were usually considered to be more important.

A model that combines offshoring, innovation, and imitation has been proposed by Benz (2012) who analyzes the effect of task trade with increasing costs on the relationship of intellectual property rights and the innovation rate.[3] In this model, innovation and imitation are endogenous processes, rewarded with monopoly profits in future periods. Northern firms can offshore their production to the South to save on short-run production costs and increase incentives for innovation. At the same time however, offshoring increases the leakage of knowledge to the South and thus the risk of imitation. An important shortcoming of this model is that it cannot give predictions on wage inequality within a country, since there only exists one homogenous type of labor. To overcome this deficit, I introduce the notion of high-skilled researchers and low-skilled production workers. I can show that more channels are opened up by which offshoring affects wages than in the existing literature In addition to the productivity effect and labor supply effect of offshoring, well-known from Grossman & Rossi-Hansberg (2008), there exists a short-run intertemporal profit effect and long-run composition and spillover effects.[4] In the short-run this makes it more likely that the skill premium is reduced when the offshoring volume increases, whereas in the long-run it is less likely. Moreover, I analyze other comparative statics effects, such as from changes in factor endowments and intellectual property rights (IPR) legislation.

Other closely related papers that have analyzed wage inequality in a dynamic setup are Sayek & Sener (2006) and Hsu (2011), albeit both assume an exogenous imitation rate and an exogenous offshoring volume. The further finds that an exogenous increase in offshoring raises the Northern skill premium, while the effect on the Southern skill premium depends

[3]The product cycle literature started out as an idea by Vernon (1966) and being formalized later on by Grossman & Helpman (1991) in a variety expansion model and a quality ladder model by Segerstrom *et al.* (1990). Other important contributions, subsequently introducing FDI and endogeneizing the imitation decision are Helpman (1993), Lai (1998), Glass & Saggi (2002), Branstetter *et al.* (2007), and Branstetter & Saggi (2009). For a detailed discussion of this literature, see Benz (2012).

[4]My model does not feature a relative price effect since I focus on a one-sector economy.

on the relative skill intensity of the offshored Northern good relative to the Southern good. Hsu (2011) uses a three-factor model to show that exogenous offshoring makes the type of production worker gain who is underproportionally used in production of the offshored good, whereas researchers always gain from more offshoring. The structure of the paper is as follows. Section 2 presents the main relationships of my model, while section 3 derives the main results and section 4 concludes.

2 The Model

The model economy consists of two countries, North and South. Each country is inhabited by a fixed amount of consumers L, of which a fraction $h_k \, \forall k \in N, S$ is of a high-skilled type and a fraction $1 - h_k$ is of the low-skilled type. All consumers supply one unit of labor inelastically.

2.1 Consumer Optimization

The intertemporal utility function of a representative consumer is given by

$$W = \int_0^\infty U(t) e^{-\rho t} \mathsf{d}t \tag{1}$$

where ρ is the discount factor and the utility in each period $U(t)$ has the form

$$U(t) = \left(\int_0^{N(t)} x_j(t)^{\frac{\sigma-1}{\sigma}} \mathsf{d}j \right)^{\frac{\sigma}{\sigma-1}} \tag{2}$$

where $x_j(t)$ is consumption of variety j at time t and σ is the constant elasticity of substitution between varieties. Intratemporal utility maximization yields a demand function

$$x_j(t) = \frac{E(t) p_j(t)^{-\sigma}}{\int_0^{N(t)} p_j(t)^{1-\sigma} \mathsf{d}j} \tag{3}$$

where $p_j(t)$ is the price of variety j at time t and the term in the denominator is the well-known Dixit-Stiglitz price index. Intertemporal utility W is maximized subject to an intertemporal

budget constraint

$$\int_0^\infty e^{-rt}E(t)\mathsf{d}t \leq \int_0^\infty e^{-rt}w(t)\mathsf{d}t + A(t) \tag{4}$$

with $E(t)$ as consumer expenditure and $A(t)$ is the value of assets in period t. This implies the usual Euler equation for consumption expenditure derived from intertemporal welfare maximization

$$\frac{\dot{E}}{E} = r - \rho. \tag{5}$$

Wages, prices, and thus expenditure are assumed to be constant over time so that utility per period rises linearly with the number of varieties available.

2.2 Manufacturing Sector

Firms produce different varieties of an otherwise identical consumption good. Precondition for production of a variety is the existence of a blueprint which is not revealed to other firms in the economy. Blueprints for production in the North must previously be developed by high-skilled workers in an innovative research sector. Innovation in the South is prohibitively costly. However, in the South there exists an imitative research sector employing high-skilled labor and copying existing Northern varieties, which thereafter can be produced by a Southern firm. Subsection 2.3 below describes in more detail how blueprints in the two countries are developed.

Production of each variety requires the performance of a unit interval of tasks that only differ in the costs that are caused if they are performed offshore. I refer to these costs as offshoring costs. These costs are generally assumed to represent such things as the content of tacit information of each task. However, the concept is sufficiently general to accommodate more features to the costs of unbundling the production process. These may include the more difficult transmission of knowledge from production to the research sector when production is performed abroad, such as in Naghavi & Ottaviano (2009). As is standard in the offshoring literature, I order tasks from 0 to 1 with a index i such that the offshoring cost schedule rises monotonously in i. Offshoring costs are thus represented by $\beta\tau(i)$, with $\tau(i) \geq 1$, $\tau'(i) \geq 0$ and $\beta \geq 1$ as technological offshoring costs.

Production tasks are exclusively performed by low-skilled workers. By assumption, their wages in the South are lower than those for their Northern counterparts $w/w^* > 1$. This allows Northern firms to resort to offshore production of all tasks $i \leq I$, where I is the marginal task implicitly defined by

$$\beta\tau(I) = \frac{w}{w^*}, \tag{6}$$

so that offshoring costs for the marginal task equal the wage of Northern workers relative to Southern workers. As shown by Grossman & Rossi-Hansberg (2008), this implies per-unit production costs of $w\Theta(I)$, where the offshoring saving factor is defined as

$$\Theta(I) := 1 - I + \frac{\int_0^I \tau(i)di}{\tau(I)} \tag{7}$$

with $\Theta'(i) \leq 0 \, \forall \, i$. The market for final goods is characterized by monopolistic competition with an elasticity of substitution σ between varieties. This yields markup pricing with $p = w\Theta(I)\sigma/(\sigma - 1)$ in the North. Profits for each Northern firm are thus given by

$$\pi = (p - w\Theta(I))x = \frac{w\Theta(I)x}{\sigma - 1} \tag{8}$$

where one should bear in mind that x is still endogenous in this relationship, depending on w and I.

Southern firms produce varieties that have been successfully imitated. Due to the wage difference they do not use offshore production. Thus, their per-unit production costs are simply given by w^*. With positive offshoring costs as described above, necessarily $w^* \leq w\Theta(I)$. I assume that the wage difference in the two countries is sufficiently high so that Southern firms can set monopoly prices according to the elasticity of substitution, the so called "wide-gap case" from Grossman and Helpman (1991). This case is formally characterized by the condition $w^*\sigma/(\sigma - 1) \geq w\Theta(I)$ or $\beta\tau(I)\Theta(I)\sigma/(\sigma - 1) \leq 1$.[5] Thus, Southern firms earn profits

$$\pi^* = (p - w^*)x^* = \frac{w^*x^*}{\sigma - 1}. \tag{9}$$

[5] In the "narrow-gap case" Southern firms set prices slightly below Northern firms' production costs to capture the entire demand for that variety. This limit price-setting can also be interpreted as Bertrand price competition.

Given the preference structure, relative demand for varieties from the two countries only depends on relative prices such that

$$\frac{x}{x^*} = \frac{p}{p^*}^{-\sigma} = [\Theta(I)\beta\tau(I)]^{-\sigma} \tag{10}$$

and the relative profits of the two types of firms are given by

$$\frac{\pi}{\pi^*} = [\Theta(I)\beta\tau(I)]^{1-\sigma} \tag{11}$$

2.3 Research Sector

Research conducted by high-skilled workers during one time period yields a success with a certain probability $1/a$. With lots of researchers, however, there is no aggregate uncertainty in the innovation process, despite of the presence of idiosyncratic uncertainty. Hence, a blueprint for a new variety can be developed in the North at a cost $C = sa/N$, where s is the salary of the high-skilled and N is as above the stock of all consumed varieties, which is identical to all blueprints ever developed in the North. The appearance of N in this cost equation is a spillover from present knowledge in line with Grossman & Helpman (1991), Aghion & Howitt (1992), or Romer (1990).[6] Successful research in the South means the disclosure of a Northern production blueprint and entails costs $C^* = s^*a^*/\gamma nI$, where $\gamma \in (0;1]$ is a parameter that characterizes protection of intellectual property rights (IPR) and n is the stock of Northern production blueprints not already disclosed to Southern firms. Intuitively, imitation is less costly when γ is close to 1, meaning little IPR protection and when the number of unrevealed varieties is high. Moreover, imitation is less costly if the share of offshore provided tasks is high, since it increases the Southern knowledge about Northern varieties. As already mentioned above, the growth rate of all Northern varieties is defined as $g := \dot{N}/N$, which on the balanced growth path is also the growth rate of unrevealed Northern varieties $\dot{n}/n$ and of Southern varieties $\dot{n}^*/n^*$. The imitation rate is $m := \dot{n}^*/n$.

Entry into research is free in both countries. I abstain from analyzing the trivial case

[6] Jones (1995) argues that spillovers have the form N^ϕ with $0 < \phi < 1$. This "semi-endogenous growth theory" makes the growth rate exogenous, only depending on the population growth rate.

where research is not profitable and, hence, the rate of variety development is equal to zero. Instead I assume that the no arbitrage condition holds with equality, giving a relationship of per-period profits and the value of a Northern firm as

$$\pi + \dot{v} = rv + mv \tag{12}$$

which implies that profits from successful innovation exactly compensate for interest payments forgone and the risk of loosing the entire firm value through imitation. The imitation risk term mv drops out for the Southern no arbitrage condition, yielding $\pi^* + \dot{v}^* = rv^*$.

With my assumption on constant expenditure over time I have $r = \rho$, as shown above. Furthermore I know that firm values decrease at a rate of g. Using the fact that the value of a firm must equal the cost of research in equilibrium I obtain

$$\frac{sa}{N} = \frac{\pi}{\rho + g + m} \qquad \text{and} \qquad \frac{s^* a^*}{\gamma n I} = \frac{\pi^*}{\rho + g} \tag{13}$$

so that output in the two countries is given by

$$nx = \frac{s}{w}\frac{\rho + g + m}{g + m}\frac{ag}{\Theta(I)}(\sigma - 1) \qquad \text{and} \qquad n^* x^* = \frac{s^*}{w^*}\frac{g + \rho}{g}\frac{a^* m}{\gamma I}(\sigma - 1). \tag{14}$$

Furthermore, from equation (13) I can solve for the relative profits of Northern and Southern firms as

$$\frac{\pi}{\pi^*} = \frac{s}{s^*}\frac{\rho + g + m}{\rho + g}\frac{g}{g + m}\frac{a\gamma I \beta \tau(I)}{a^*}. \tag{15}$$

2.4 Labor Markets

I assume that high-skilled workers are only active in the respective research sectors of the two economies, whereas low-skilled workers perform production tasks. For Southern workers this implies that they are free to move between local production and offshore production by Northern firms.

Thus, the full employment condition for high-skilled workers are easily characterized. They

are given by

$$h_N L = ag \qquad \text{and} \qquad h_S L^* = \frac{a^* m}{\gamma I} \tag{16}$$

and serve to pin down the growth rate in the steady state and the imitation rate, once the offshoring volume is determined.

Northern low-skilled workers only perform a fraction $1 - I$ of tasks domestically. Their full employment condition satisfies

$$(1 - h_N)L = (1 - I)nx \tag{17}$$

and inserting from above I obtain

$$\begin{aligned}(1 - h_N)L &= \frac{s}{w}\frac{1 - I}{\Theta(I)}ag\frac{g + \rho + m}{g + m}(\sigma - 1) \\ &= h_N L\frac{(1 - I)}{\Theta(I)}\frac{s}{w}\frac{h_N L/a + \gamma I h_S L^*/a^* + \rho}{h_N L/a + \gamma I h_N L^*/a^*}(\sigma - 1)\end{aligned} \tag{18}$$

Analogously, full employment in the South is given by

$$(1 - h_S)L^* = \beta\int_0^I \tau(i)\mathsf{d}inx + n^* x^* \tag{19}$$

which can be written as

$$\begin{aligned}(1 - h_S)L^* &= \frac{s^*}{w^*}\frac{a^* m}{\gamma I}\frac{\rho + g}{g}(\sigma - 1) + \frac{h_N L}{\Theta(I)}\frac{s}{w}\frac{g + \rho + m}{g + m}(\sigma - 1)\beta\int_0^I \tau(i)\mathsf{d}i \\ &= h_S L^*\frac{s^*}{w^*}\frac{h_N L/a + \rho}{h_N L/a}(\sigma - 1) \\ &\quad + \frac{h_N L}{\Theta(I)}\frac{s}{w}\frac{h_N L/a + \gamma I h_S L^*/a^* + \rho}{h_N L/a + \gamma I h_N L^*/a^*}(\sigma - 1)\beta\int_0^I \tau(i)\mathsf{d}i\end{aligned} \tag{20}$$

where the first term on the right-hand-side represents labor in Southern production while the second term is labor used for Northern offshore production.

3 Wage Inequality

3.1 North

From equation (18) I can solve for the Northern skill premium and use ω to refer to it

$$\omega := \frac{s}{w} = \frac{1-h_N}{h_N}\frac{\Theta(I)}{1-I} \cdot \frac{h_N L/a + \gamma I h_S L^*/a^*}{h_N L/a + \gamma I h_S L^*/a^* + \rho} \cdot \frac{1}{\sigma - 1} \tag{21}$$

This term for the skill premium consists of three components: First, efficiency units of low skilled workers in domestic production relative to high-skilled workers. Second, the inverted share of Northern production relative to the discount rate of firm profits. And third, firm profits relative to production costs. The third term only depends on the elasticity of substitution between varieties.

Given the relationships derived above I can now proceed to analyze the reaction of the Northern skill premium on changes in the offshoring volume. The effect can be split up into three components. The first and the second correspond to the well-known productivity effect and labor supply effect, respectively, from Grossman & Rossi-Hansberg (2008).[7] Note that the productivity effect is negative since it works in favor of low-skilled labor, while the labor supply effect works in favor of researchers and, hence, is positive. Moreover, there exist two further effect that are innate to dynamic analysis and are both induced by an increase in the imitation rate. First, the intertemporal profit effect implies a reduction of the skill premium, due to a higher discount rate of future profit streams that harms highs-skilled researchers. However, it is dominated by the composition effect. The declining share of Northern varieties reduces demand for production labor and thus induces an increase of the skill premium. I use a hat on a variable to refer to relative changes and thus can write the above outlined relationship as

$$\hat{\omega} = \hat{\Theta}(I) + \mu_2 \frac{\mathrm{d}I}{1-I} + \mu_3 \hat{m}(I) \tag{22}$$

[7] My analysis differs from Grossman & Rossi-Hansberg (2008) by having high-skilled researchers as fixed cost of production, a non-homothetic technology as coined by Horn (1983), whereas Grossman & Rossi-Hansberg (2008) use a Leontieff-type production technology. Hence, they do not focus on skill premia, but analyze changes in the wages of the high-skilled and low-skilled separately.

where

$$\mu_3 := \frac{\rho m}{g+m} - \frac{\rho m}{g+m+\rho} > 0 \tag{23}$$

and the imitation rate m is evaluated at its initial level. The analysis by Grossman & Rossi-Hansberg (2008) concerning the relative strength of the productivity effect and labor supply effect applies here as well. The first bit of offshoring does not feature a productivity increase and, hence, works unambiguously in favor of high-skilled researchers. However, the productivity effect may dominate the labor supply effect when the offshoring volume is large and the offshoring cost schedule $\tau(i)$ rises steeply.

Considering the timing of events more explicitly, it is trivial to see that the productivity effect and labor supply effect set in instantaneously. The same is true for the intertemporal profit effect. In the short-run, this leads to an increase in the probability that the high-skilled are harmed from offshoring, relative to low-skilled workers. The negative intertemporal profit effect and productivity effect might dominate the positive labor supply effect. However, in the long-run, when the composition of produced varieties has adjusted, the dynamic composition effect kicks in, working in favor of high-skilled researchers. In the long-run, the set of constellations in which low-skilled workers gain from offshoring is reduced.

An increase in the share of high-skilled researchers in the Northern economy can be decomposed into a direct labor supply effect and a indirect intertemporal profit effect, composition effect, and spillover effect. The intertemporal profit effect benefits production workers in the short-run because the discount rate is driven up instantaneously, reducing returns from innovation. However, in the long run, the composition and spillover effects kick in. The composition effect works in favor of the low-skilled workers since a larger share of varieties is manufactured in the North. However, it is dominated by increasing research spillovers that benefit high-skilled researchers. Jointly they more than compensate for the increase in the discount rate and thus contribute to a rising skill premium, but are dominated by the direct negative labor supply effect. In relative changes I can write

$$\hat{\omega} = \left(-\frac{1}{(1-h_N)h_N} + \frac{\rho g}{g+m} - \frac{\rho g}{g+m+\rho} \right) \hat{h}_N \tag{24}$$

where the first term is the labor supply effect, the second term is the positive joint spillover and composition effect, and the third term is the intertemporal profit effect. The growth rate g is evaluated at the initial level of h_N. Since $1 > (1 - h_N)h_N$, $\rho g < g + m$, and $\rho g < g + m + \rho$ the first term always dominates. Hence, high-skilled researchers lose from becoming more numerous relative to low-skilled workers. Note that this analysis holds I constant. Letting the offshoring volume adjust endogenously, it is likely to see I increase which could partially offset the negative effect on the skill premium.

Increasing the number of high-skilled researchers and holding the number of low-skilled workers constant has a positive effect on the skill premium. This can be seen from the fact that

$$\hat{\omega} = \left(\frac{\rho g}{g + m} - \frac{\rho g}{g + m + \rho} \right) \hat{L} \tag{25}$$

which is strictly positive as I pointed out above when analyzing exogenous changes in h_N. A direct labor supply effect is not present here.

A tightening of intellectual property rights in the South, a reduction of γ, reduces the long-run skill premium in the North when I is hold constant

$$\hat{\omega} = \left(\frac{\rho m}{g + m} - \frac{\rho m}{g + m + \rho} \right) \hat{\gamma} \tag{26}$$

The mechanism works entirely through the change in profit discounting and the composition of varieties. In the short-run, the skill premium is raised by a reduction in the discount rate of Northern profits that works in favor of researchers. However, in the long-run, tighter IPR legislation reduces imitation possibilities and thus reduces the share of Southern varieties. Consequently, more of each Northern variety is produced and demand for Northern production labor increases. The second effect always dominates. Such a tightening of IPR legislation has exactly the same effect as a reduction in Southern endowment L^*.

3.2 South

Inserting equation (21) into (20) yields the Southern skill premium

$$\omega^* := \frac{s^*}{w^*} = \frac{(1-h_S)L^* - (1-h_N)L\frac{\beta}{1-I}\int_0^I \tau(i)\mathrm{d}i}{h_S L^*} \cdot \frac{h_N L/a}{h_N L/a + \rho} \cdot \frac{1}{\sigma - 1}. \tag{27}$$

which again consists of three terms: production workers left for Southern production relative to Southern researchers; discount rate of profits relative to research productivity; and firm profits relative to production costs.

It is easy to see that the skill premium in the South decreases with a higher offshoring volume, $\partial\omega^*/\partial I < 0$. Here there only is a first order labor demand effect. The composition and discounting effect is not present since its two components exactly cancel each other out. On the one hand, offshoring increases research productivity that contributes to rising salaries for researchers. But on the other hand, the higher share of Southern varieties increases demand for Southern production labor and drives up their wages by the same amount.

By the same token, an increase in the share of Southern high-skilled researchers decreases the skill premium, $\partial\omega^*/\partial h_S < 0$. Again, there is only a first order effect, since the two dynamic long-run effects exactly cancel each other out. As above, this analysis holds I constant. An endogenously reduced offshoring volume could partially offset the negative effect on the skill premium.

Moreover, I find that an increase in the share of Northern high-skilled researchers increases the skill premium in the South for a constant I, $\partial\omega^*/\partial h_N > 0$. Firstly, there is a negative labor supply effect, since output of each Northern variety is reduced and less Southern production workers are needed in offshore production sites. Furthermore, there is a positive indirect effect, since the research productivity in the South due to spillovers from the North increases more than the discount rate of research profits.

Interestingly, varying the strength of intellectual property rights has no effect on the skill premium in the South when I is hold constant, since both types of labor are affected equally from such a policy change.

4 Conclusion

In this paper I analyze dynamic long-run effects on the skill premium, the wage of high-skilled researchers relative to low-skilled production workers, in a model with endogenous choices of offshoring, innovation, and imitation. This model combines two strands of the literature, the classical product cycle models and the recent offshoring models. I find that in such a dynamic model there exist additional channels by which exogenous variables may affect the skill premium that so far have not been analyzed in the literature.

Considering the influence of offshoring on skill premium in the Northern economy as analyzed by Grossman & Rossi-Hansberg (2008), I find that, in addition to the well-known productivity effect and labor supply effect, there exists a short-run intertemporal profit effect, as well a long-run composition effect. The endogenous composition of Northern and Southern varieties in the new steady state contributes to drive up the Northern skill premium in the long-run when the offshoring volume is raised. In the short run, however, the probability of a decline in the skill premium from intensified offshoring is increased, due to a rising discount rate of future profit streams that harms high-skilled researchers.

Moreover, I analyze the comparative statics of Northern endowment shares on the skill premia in the two countries, holding the offshoring volume I constant. In the short run, a rising discount rate of profits harms high-skilled researchers in addition to the well-known labor supply effect when they become more numerous. The long-run effect from changes in the composition of varieties further harms researchers, but increasing research spillovers can compensate for negative intertemporal profit and composition effect. Nevertheless, these joint indirect effects are clearly dominated by the direct labor-supply effect. On the other hand, Southern researchers gain in the short run and the long run from a rising researcher-share in the North, due to a reduction of low-skilled employment in offshore facilities and due to increasing research spillovers.

Changing the share of Southern researchers only has a static labor supply effect on the Southern skill premium, the Northern skill premium is not affected. In the short-run, tighter intellectual property rights in the South benefit Northern researchers relative to production

workers due to a lower discount rate. However, the long run composition effect reverses this pattern. The skill premium in the South remains unaffected, since both types of labor are affected identically.

References

Arndt, Sven W. 1997. Globalization and the Open Economy. *North American Journal of Economics and Finance*, **8**, 71–79.

Benz, Sebastian. 2012. Boon or bane: The impact of intellectual property rights on innovation. *Unpublished Manuscript*.

Benz, Sebastian, & Kohler, Wilhelm. 2011. Managerial Versus Production Wages: Offshoring, Country Size and Endowment. *University of Tuebingen, Working Papers in Economics and Finance No. 13*.

Berman, Eli, Bound, John, & Griliches, Zvi. 1994. Changes in the Demand for Skilled Labor within U.S. Manufacturing: Evidence from the Annual Survey of Manufactures. *Quarterly Journal of Economics*, **104**, 367–398.

Branstetter, Lee, & Saggi, Kamal. 2009. Intellectual Property Rights, Foreign Direct Investment, and Industrial Development. *NBER Working Paper*, **no. 15393**.

Branstetter, Lee, Fisman, Raymond, Foley, Fritz, & Saggi, Kamal. 2007. Intellectual Property Rights, Imitation, and Foreign Direct Investment: Theory and Evidence. *NBER Working Paper*, **no. 13033**.

Deardorff, Alan V. 2000. Factor Prices and the Factor Content of Trade Revisited: What is the Use? *Journal of International Economics*, **50(1)**, 73–90.

Egger, Hartmut, & Falkinger, Josef. 2003. The Distributional Effects of International Outsourcing in a 2x2 Models. *North American Journal of Economics and Finance*, **14(2)**, 189–206.

Egger, Hartmut, & Kreickemeier, Udo. 2005. International Fragmentation: Boon or Bane for Domestic Employment. *European Economic Review*, **52**, 116–132.

Feenstra, Robert C., & Hanson, Gordon H. 1997. Foreign direct investment and relative wages: evidence from Mexico's Maquiladoras. *Journal of International Economics*, **42**, 371–393.

Feenstra, Robert C., & Hanson, Gordon H. 1999. The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979-1990. *Quarterly Journal of Economics*, **114(3)**, 907–940.

Glass, Amy Jocelyn, & Saggi, Kamal. 2002. Intellectual Property Rights and Foreign Direct Investment. *Journal of International Economics*, **56(2)**, 387–410.

Grossman, Gene M., & Helpman, Elhanan. 1991. Endogenous Product Cycles. *Economic Journal*, **101(408)**, 1214–1229.

Grossman, Gene M., & Rossi-Hansberg, Esteban. 2008. Trading Tasks: A Simple Theory of Offshoring. *American Economic Review*, **98(5)**, 1978–1997.

Helpman, Elhanan. 1993. Innovation, Imitation and Intellectual Property Rights. *Econometrica*, **61(6)**, 1247–1280.

Horn, Henrik. 1983. Some Implications of Non-Homotheticity in Production in a Two-Sector General Equilibrium Model with Monopolistic Competition. *Journal of International Economics*, **14**, 85–101.

Hsu, Kuang-Chung. 2011. Does Outsourcing Always Benefit Skilled Labor. *Review of International Economics*, **19(3)**, 539–554.

Hummels, David, Ishii, Jun, & Yi, Kei-Mu. 2001. The Nature and Growth of Vertical Specialization in World Trade. *Journal of International Economics*, **54(1)**, 75–96.

Kohler, Wilhelm. 2003. The Distributional Effects of International Outsourcing. *German Economic Review*, **40**, 89–120.

Krugman, Paul R. 2000. Technology, trade and factor prices. *Journal of International Economics*, **50(1)**, 51–71.

Lai, Edwin. 1998. International intellectual property rights protection and the rate of product innovation. *Journal of Development Economics*, **55**, 133–153.

Lawrence, Robert Z., & Slaughter, Matthew. 1993. International Trade and American Wages in the 1980s: Giant Sucking Sound or Small Hiccup? *Brookings Papers on Economic Activity: Microeconomics*, 161–226.

Leamer, Edward E. 2000. What's the use of factor-contents? *Journal of International Economics*, **50(1)**, 17–49.

Panagariya, Arvind. 2000. Evaluating the factor-content approach to measuring the effect of trade on wage inequality. *Journal of International Economics*, **50(1)**, 91–116.

Sayek, Selin, & Sener, Fuat. 2006. Outsourcing and Wage Inequality in a Dynamic Product Cycle Model. *Review of Development Economics*, **10(1)**, 1–19.

Segerstrom, Paul S., Anant, T.C.A., & Dinopoulos, Elias. 1990. A Schumpeterian Model of the Product Life Cycle. *American Economic Review*, **80(5)**, 1077–1091.

Trefler, Daniel, & Zhu, Susan Chun. 2005. Trade and Inequality in Developing Countries: A General Equilibrium Analysis. *Journal of International Economics*, **65**, 21–48.

Venables, Anthony J. 1999. Fragmentation and multinational production. *European Economic Review*, **43**, 935–945.

Vernon, Raymond. 1966. International Investment and International Trade in the Product Cycle. *Quarterly Journal of Economic*, **80**, 190–207.

Yeats, Alexander J. 2001. Just How Big Is Global Production Sharing. *In:* Arndt, S.W., & Kierzkowski, H. (eds), *Fragmentation: New Production Patterns in the World Economy*. Oxford University Press.

Yi, Kei-Mu. 2003. Can Vertical Specialization Explain the Growth of World Trade. *Journal of Political Economy*, **111(1)**, 52–102.