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Industrialisation and the Big Push in a Global Economy*

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Abstract

In their famous paper on the "Big Push", Murphy, Shleifer, and Vishny (1989) show how the combination of increasing returns to scale at the firm level and pecuniary externalities can give rise to a poverty trap, thereby formalising an old idea due to Rosenstein-Rodan (1943). We develop in this paper an oligopoly model of the Big Push that is very close in spirit to the Murphy-Shleifer-Vishny (MSV) model, but in contrast to the MSV model it is easily extended to the case of an economy that is open to international trade. Having a workable open-economy framework allows us to address the question whether globalisation makes it easier or harder for a country to escape from a poverty trap. Our model gives a definite answer to this question: Globalisation makes it harder to escape from a poverty trap since the adoption of the modern technology at the firm level is impeded by tougher competition in the open economy.

JEL-Classification: F12, O14, F43

Keywords: Poverty Traps, Multiple Equilibria, International Trade, Technology Upgrading, General Oligopolistic Equilibrium

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1 Introduction

> *"Let us assume that 20,000 unemployed workers [...] are taken from the land and put into a large shoe factory. They receive wages substantially higher than their previous meagre income in natura. [...] If these workers spent all their wages on shoes, a market for the products of their enterprise would arise [...]. The trouble is that the workers will not spend all their wages on shoes."*
>
> *"If, instead, one million unemployed workers were taken from the land and put, not into one industry, but into a whole series of industries which produce the bulk of the goods on which the workers would spend their wages, what was not true in the case of one shoe factory would become true in the case of a whole system of industries: it would create its own additional market, thus realising an expansion of world output with the minimum disturbance of the world markets."*
>
> (Rosenstein-Rodan, 1943, pp. 205-206)

Rosenstein-Rodan's (1943) story of a shoe factory is often regarded as a prototypical description of a poverty trap: a large modern factory, if established, would generate positive demand spillovers for other sectors, but it cannot break even unless modern factories in other sectors are established that themselves generate comparable demand spillovers. A coordinated "Big Push" towards modernisation across all sectors could therefore be achievable, while each sector on its own would be bound to fail in its effort to modernise. Murphy et al. (1989), in a celebrated and widely cited paper, were the first to formalize Rosenstein-Rodan's (1943) idea of a Big Push, in a closed economy model with a continuum of sectors, increasing returns to scale at the firm level, and pecuniary externalities between sectors.[1] In their model, a single firm in each sector can upgrade its traditional constant-returns-to-scale (CRS) technology to a modern increasing-returns-to-scale (IRS) technology, becoming a limit-pricing monopolist. Due to the assumption that modern firms have to pay higher wages, modernisation in an individual sector increases aggregate demand even if the individual firm suffers a loss from adopting the modern technology. If technology upgrading decisions are coordinated across sectors, these mutually beneficial demand spillovers can be fully internalised, rendering the adoption of the Pareto-superior modern technology not only socially optimal but also individually profitable.

Although celebrated for the revival of what Krugman (1993) subsumes under the term "high development theory" (cf. Rosenstein-Rodan, 1943; Nurkse, 1952; Fleming, 1955), the Murphy-Shleifer-Vishny model early on faced the criticism that insufficient domestic demand should matter much less as a cause for multiple equilibria in an economy that is open to international trade (cf. Fn. 24 in Matsuyama (1991) and Fn. 3 in Stiglitz (1993)). Anticipating this caveat, Murphy et al. (1989) spend a whole section on highlighting the importance of the domestic market as an outlet for sales of domestic industries. Based on evidence from the

[1]There is a rich literature on the conditions under which various kinds of poverty traps may arise. Recent surveys are provided by Azariadis and Stachurski (2005), Matsuyama (2008), and Kraay and McKenzie (2014).

1950s, 1960s and 1970s (cf. Chenery and Syrquin, 1975; Chenery et al., 1986) they conclude that industrial growth can be largely attributed to an expansion in domestic demand. Even today most countries' trading patterns are a far cry from the scenario of a world without any trading frictions. Nevertheless, economies are much more open now than they used to be in the past, with world imports of goods and services relative to world GDP strongly on the rise, from 12% in 1960 to 30% in 2011 (Head and Mayer, 2013).

The contribution of our paper is to develop a model that allows in a straightforward way the analysis of an economy that is open to international trade, but at the same time is very close in spirit to the original Murphy-Shleifer-Vishny model (henceforth MSV). In particular, our model shares the property of the MSV model that poverty traps arise due to the co-existence of pecuniary externalities between sectors and increasing returns to scale at the firm level. Where we differ from the MSV model is in the assumed market structure and in the specification of demand. This is important, since the original MSV model's clever combination of asymmetric Bertrand competition and Cobb-Douglas demand, which greatly simplifies the analysis of the closed-economy model, at the same time immensely complicates the incorporation of international trade: Quasi-rents from technology adoption and therefore the incentives to modernise are eliminated if two or more modern firms from different countries compete over the prices of homogeneous goods and therefore end up in the Bertrand paradox.[2] And Cournot competition is not a natural alternative in the MSV model, since the demand is assumed to be iso-elastic.[3] In our model, we stick to the assumption from MSV that firms face a binary choice between CRS and IRS technologies, and introduce this assumption into a general equilibrium oligopoly model à la Neary (2003) with Cournot competition and linear demand, which straightforwardly allows the analysis of a trading world economy with many symmetric countries.

Within this new framework firms charge variable mark-ups, which – unlike in the MSV model – are not decoupled from the model's general equilibrium effects. As a consequence, our model features a new equilibrium type. In addition to the two polar cases familiar from Murphy et al. (1989), in which the modern IRS technology is adopted either in no sector or simultaneously by all sectors, there also is the possibility of an equilibrium with incomplete industrialisation, in which the IRS technology is adopted only by a subset of all sectors.[4] The variability of mark-ups

[2]Intuitively, the Bertrand paradox only arises under free trade. In the presence of non-prohibitive (variable) trade costs modern firms in each country would resort to a limit pricing strategy, slightly undercutting the foreign competitors' unit costs. With entry into the foreign market being effectively blocked, investments into increasing-returns-to-scale technologies would be again constrained by the (initial) size of the domestic market, potentially giving rise to multiple equilibria in the open economy. As an obvious drawback of this modelling strategy the open-economy equilibrium would feature zero international trade (cf. Neary and Leahy, 2015).

[3]As pointed out by Neary (2016), with iso-elastic demand quantities are strategic complements for many parameter values. Moreover, reaction functions may be non-monotonic. Bandyopadhyay (1997) demonstrates the complexities that arise with iso-elastic demands even in the simplest Cournot duopoly.

[4]See Paternostro (1997) for a model of poverty traps, in which equilibria with incomplete industrialisation are

thereby matters in two ways. On the one hand, early adopters of the modern IRS technology can (more) easily divert expenditure away from other sectors by charging lower mark-ups. On the other hand, mark-ups are generally decreasing throughout all sectors, as workers' wages (and, hence, firms' costs) are steadily increasing in the process of industrialisation. Both effects benefit early adopters vis-à-vis their later followers, such that the gains from modernisation are gradually reduced as the modern IRS technology is adopted in more and more sectors, eventually leading to an equilibrium in which technology adoption pays off only for firms in a subset of all industries.

We characterise a precise condition under which our model is capable of producing multiple equilibria.[5] Having established the existence of multiple equilibria, we derive a sufficient condition for the existence of a poverty trap, in which the economy might end up being caught in a low-welfare equilibrium characterised by incomplete industrialisation. Thereby it is important to disentangle the two welfare effects that are associated with a gradual industrialisation. Intuitively, if the modern technology is socially efficient, a rising share of modernised sectors is associated with rising welfare as the economy's average technology improves. However, as demonstrated by Neary (2016), consumers also benefit from the possibility to shift their consumption towards relatively cheaper goods, which becomes possible in an incompletely industrialised equilibrium, that is characterised by an inter-sectoral heterogeneity in firm-level productivities. With multiple equilibria it therefore has to be ensured that the incompletely industrialised equilibrium is actually inferior in terms of welfare relative to the equilibrium with complete industrialisation.

When analysing the role of globalisation, we focus on the pro-competitive effect of international trade, which is a specific feature of our oligopolistic trade model, that cannot be studied within canonical models of monopolistic competition with constant mark-ups (cf. Krugman and Elizondo, 1996; Sachs and Warner, 1999; Trindade, 2005). In contrast to this class of models, in which an increase in the number of trading partners in the presence of external increasing returns to scale (cf. Ethier, 1982) typically is associated with a lifting-all-boats effect of globalisation, we find that the vicious cycle of poverty in our model is reinforced through the pro-competitive effect of international trade. In particular, we show that for an economy, which, due to an insufficiently small market, is initially trapped in an incompletely industrialised low-welfare

derived under the additional assumption of a positive fixed cost externality.

[5]Since we place our analysis in a perfectly integrated world economy, it is worth to note that the existence of multiple equilibria does not depend on the assumption that world trade is sufficiently costly, as suggested by Matsuyama (1991, Fn. 34) or by Stiglitz (1993, Fn. 3). As in a closed economy with initially too small market size, a multiplicity of equilibria can also arise in an open economy if the world market initially is too small. In either case, industrialisation becomes a self-fulfilling prophecy if the adoption of the modern technology is associated with a sufficient expansion of the market.

equilibrium, it becomes more difficult to adopt the welfare-enhancing modern IRS technology, given that trade liberalisation is associated with an erosion of firms' operating margin due to intensified competition from abroad.

For the reasons explained above, Murphy et al.'s (1989) original Big Push framework has mostly been used to conduct closed-economy analyses (cf. Matsuyama, 1992; Gans, 1997; Yamada, 1999; Ciccone, 2002; Mehlum et al., 2003; Bjorvatn and Coniglio, 2012). Studies interested in the role that international trade plays in the context of poverty traps have typically adapted models with constant mark-ups and external increasing returns to scale (cf. Ethier, 1982): Krugman and Elizondo (1996) focus on multiple spatial equilibria within a New Economic Geography (NEG) model (cf. Krugman, 1991) and show that the multiplicity of equilibria is eliminated if the economy becomes sufficiently open for international trade. According to Sachs and Warner (1999) the relative strength of (external) increasing returns to scale in non-traded versus traded goods industries determines whether a resource boom can substitute for a Big Push. Trindade (2005) uses a model with external increasing returns to scale in the production of tradable intermediates to show that the lifting-all-boats effect of export-promoting policies can push an economy from a low- to a high-welfare equilibrium. All these models have in common that both the multiplicity of equilibria and the gains from trade are derived from the presence of external increasing returns to scale à la Ethier (1982), and it is therefore no surprise that a trade-induced increasing in market size appears as a convenient way out of a pre-existing poverty trap. By disentangling the multiplicity of equilibria from the source of the gains from trade, our model sheds light on a new complementary channel (the pro-competitive effect of international trade), which turns out to be pivotal in shaping a country's prospects of breaking the vicious circle of poverty, but has so far been neglected in the literature on poverty traps.

Building on the seminal contributions of Neary (2003, 2016), the basic concept of General Oligopolistic Equilibrium (GOLE) has been applied to many contexts, including the analysis of cross-border mergers (cf. Neary, 2007), labour market imperfections (cf. Bastos and Kreickemeier, 2009; Egger and Koch, 2012; Egger and Etzel, 2012; Kreickemeier and Meland, 2013; Egger et al., 2015), and multi-product firms (cf. Eckel and Neary, 2010; Egger and Koch, 2012; Eckel et al., 2015).[6] Although we are the first to model an endogenous technology choice à la Murphy et al. (1989) in General Oligopolistic Equilibrium, there are some natural parallels to the work of Bastos and Straume (2012), who endogenise the range of products, and to the work of Neary and Tharakan (2012), who endogenise the mode of competition.

[6]See Colacicco (2015) for a recent review of the literature.

The paper is structured as follows: In Section 2 we provide a short summary of the original Murphy-Shleifer-Vishny model, following the exposition in Krugman (1993). Section 3 then characterises our model and derives a general formulation of firms' technology upgrading decision. Section 4 is structured in three Subsections: We prove the existence of multiple equilibria in a global economy in Subsection 4.1. In the subsequent Subsection 4.2 we then demonstrate under which condition this multiplicity of equilibria results in a poverty trap. Finally, in Subsection 4.3 it is shown that opening up to free trade does substitute for a Big Push that would be required to escape from a pre-existing poverty trap. Section 5 concludes.

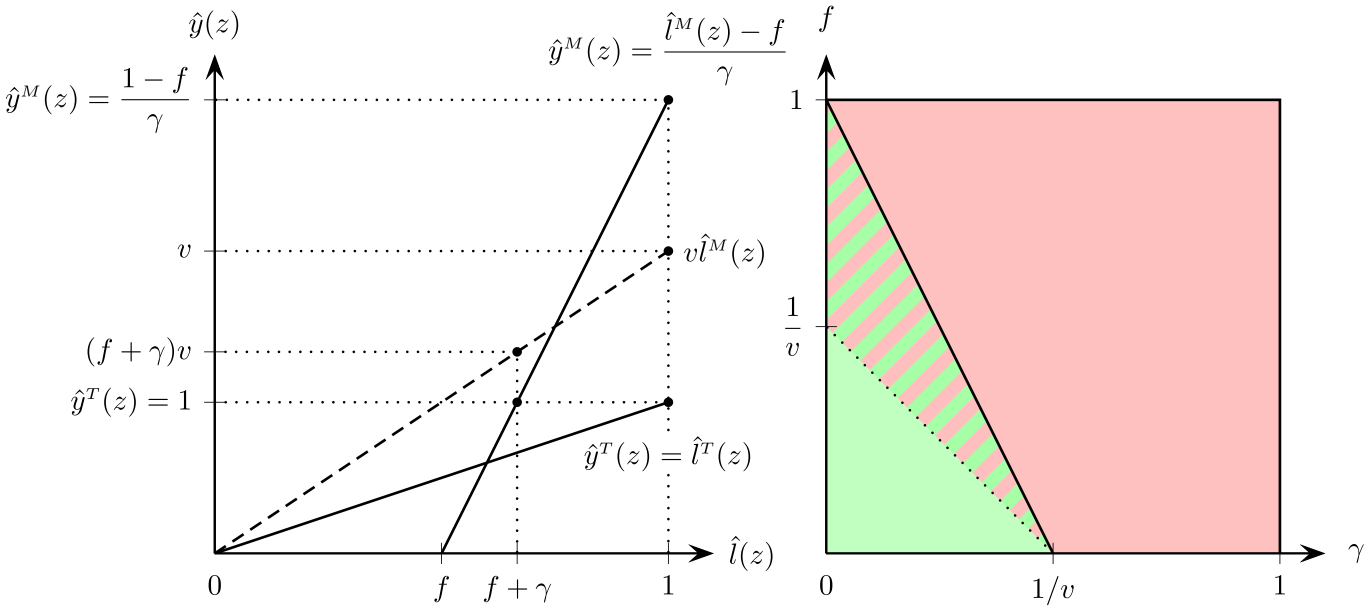
2 The Big Push Model of Murphy, Shleifer, and Vishny

We begin our analysis with a short presentation of the Big Push model by Murphy et al. (1989). Consider a closed economy with a continuum of sectors $z \in [0, 1]$ and Cobb Douglas utility $U[x(z)] = \exp[\int_0^1 \ln x(z)dz]$, in which $x(z)$ denotes consumption of good z. The economy is endowed with a fixed supply of labour $L > 0$, which also serves as *numéraire*, implying unitary wages $w \overset{!}{=} 1$. In each sector a competitive fringe of firms has access to a traditional technology $y^T(z) = l^T(z)$ (denoted by superscript T) with a unitary labour input coefficient. A single one of those firms in each sector also has access to a modern technology with increasing returns to scale (denoted by superscript M), which is characterised by production function $y^M(z) = \max\{0, [l^M(z) - F]/\gamma\}$, with $\gamma \in (0, 1)$ as marginal labour requirement, and $F \in (0, L)$ as fixed labour requirement. To adopt the modern technology and to become a monopolist, firms in each sector have to pay an exogenously given (multiplicative) wage premium $v \geq 1$.

Krugman (1993) has a particularly transparent graphical representation of the model, which is reproduced here as Figure 1a. The Figure relates *per capita* labour input $\hat{l}(z) \equiv l(z)/L$ to *per capita* sectoral output $\hat{y}(z) \equiv y(z)/L$ with $f \in (0, 1)$ being defined as $f \equiv F/L$. Solid lines represent per capita output, revenue and labour costs for the traditional technology as a ray from the origin with slope 1, and per capita output and revenue for the modern technology as a line through point f with slope $1/\gamma$. Per capita labour costs for the modern technology are given by the dashed line with slope v. If all sectors use the same technology $i \in \{T, M\}$, labour market clearing implies $L = \int_0^1 l^i(z)dz = \int_0^1 l^i dz = l^i$ (or equivalently $\hat{l}^i(z) = 1$), and per capita output under the traditional and modern technologies equals $\hat{y}^T(z) = 1$ and $\hat{y}^M(z) = (1 - f)/\gamma$, respectively. Figure 1a illustrates the interesting case of $\hat{y}^M(z) > \hat{y}^T(z)$, in which the adoption of the modern technology throughout the economy would be a Pareto improvement, requiring $(1 - f)/\gamma > 1$ or, equivalently, $f + \gamma < 1$.

The famous result of Murphy et al. (1989) is that with $v > 1$ the potential for a poverty

Figure 1: *The Big Push*



(a) *Traditional versus Modern Technology* **(b)** *Multiple versus Unique Equilibria*

trap, i.e. a situation with multiple equilibria in which industrialisation *(i)* would constitute a Pareto improvement, *(ii)* is not profitable for individual firms, and therefore does not happen, in a decentralised equilibrium, *(iii)* is profitable for all firms, and therefore does happen, if industrialisation is coordinated across sectors. To illustrate this result, suppose a single firm in a particular sector starts to modernise. The modern firm charges the same unitary (limit) price as the traditional firms and sells the same quantity $\hat{y}^T(z) = \hat{y}^M(z) = 1$ (each sector only marginally contributes to the economy as a whole such that income effects are absent in this case). To produce this quantity the modern firm incurs labour cost $(f+\gamma)v$, which may be (and in Figure 1a is) larger than 1, thereby rendering modernisation by a single firm unprofitable, even though $f + \gamma < 1$ and therefore modernisation in all sectors would be Pareto efficient.

Now suppose firms in all sectors modernise simultaneously. This move increases aggregate demand, letting all firms produce output (equal to revenue) $\hat{y}^M(z) = (1-f)/\gamma$, while labour cost is equal to v. With $(1-f)/\gamma > v$, as drawn in Figure 1a, simultaneous modernisation of all sectors is profitable. Putting together the parameter constraints, multiple equilibria occur in Murphy et al. (1989) for

$$1 - \gamma v > f > \frac{1-\gamma v}{v}, \tag{1}$$

in which the first inequality ensures that coordinated modernisation is profitable, whereas the second inequality ensures that individual modernisation is not profitable. The exogenous wage premium $v > 1$ is crucial for the existence of multiple equilibria, since it gives rise to a pecuniary demand externality, which is rationally ignored by individual firms, who consequently underinvest into the adoption of the modern technology. By coordinating their technology choices across the continuum of sectors, all firms equally contribute to an increase in aggregate demand, from which they mutually benefit, rendering the adoption of the Pareto superior modern technology profitable for each single firm as long as f is in the interval given by inequality (1).

Figure 1b depicts the boundary condition $f = 1 - \gamma v$ as a black solid line, and the boundary condition $f = (1 - \gamma v)/v$ as a black dotted line. Combinations of f and γ between both lines lead to multiple equilibria as described. In the red parameter space no sector modernises, while industrialisation always succeeds in the green parameter space.

3 Technology Upgrading in General Oligopolistic Equilibrium

In this section, we show how firms' technology upgrading decision as originally formalised in Murphy et al. (1989) can be incorporated into an otherwise standard General Oligopolistic Equilibrium (GOLE) model. Following Neary (2003, 2016), we adopt continuum-quadratic preferences

$$U[x(z)] = \int_0^1 u[x(z)]dz \qquad \text{with} \qquad u[x(z)] = \alpha x(z) - \frac{1}{2}\beta x(z)^2, \tag{2}$$

which results in a (perceived) linear demand system

$$p(z) = \frac{\alpha - \beta x(z)}{\lambda} \quad \text{and} \quad x(z) = \frac{\alpha - \lambda p(z)}{\beta} \quad \text{with} \quad \lambda = \frac{\alpha \int_0^1 p(z)dz - \beta Y}{\int_0^1 p(z)^2 dz}, \tag{3}$$

implying well-behaved best-response functions under Cournot competition.[7] Thereby, we denote sectoral demand by $x(z)$, prices by $p(z)$, and aggregate income by Y. Without loss of generality we can normalise preference parameters $\alpha, \beta \stackrel{!}{=} 1$, such that the satiation point equals $\alpha/\beta = 1$. Marginal utility of income λ is a non-linear function of *aggregate* variables only, and therefore may be interpreted as a "sufficient statistic" for how firms perceive the rest of the economy as a whole. In general equilibrium, we are free in the choice of a *numéraire*, and following Neary (2003, 2016) we choose marginal utility for this role, which implies that all prices are defined relative to the cost of marginal utility, which is given by λ^{-1}, the inverse of the marginal utility of income. With $\lambda^{-1} \equiv 1$, prices have the interpretation of *real prices at the margin*, and the same is true for wage rates.

[7] Continuum-quadratic preferences are a sub-class of the Gorman polar form (cf. Gorman, 1961). Quasi-homotheticity ensures consistent aggregation of individual demand functions within and across countries. See Neary (2016) for a detailed discussion of the demand system in Eq. (3).

We assume an integrated world economy with $m \geq 1$ symmetric countries, each having a continuum of symmetric sectors $z \in [0,1]$ with $n \geq 1$ symmetric firms in each sector. Competition is assumed to be Cournot.[8] The variable $\tilde{z}$ denotes the endogenous share of sectors using the modern technology, and it is shown below that all other model variables can be expressed as a function of $\tilde{z}$. The households' budget constraint is given by $E(\tilde{z}) = \tilde{z}p^M(\tilde{z})\bar{x}^M(\tilde{z}) + (1-\tilde{z})p^T(\tilde{z})\bar{x}^T(\tilde{z})$, with p^i as the price for goods produced by firms of type $i \in \{T, M\}$ and $\bar{x}^i$ as the total quantity consumed of the respective goods. It is helpful for the following analysis to define the new variables

$$\theta(\tilde{z}) \equiv \frac{\tilde{z}p^M(\tilde{z})\bar{x}^M(\tilde{z})}{\tilde{z}p^M(\tilde{z})\bar{x}^M(\tilde{z}) + (1-\tilde{z})p^T(\tilde{z})\bar{x}^T(\tilde{z})} \in [0,1], \tag{4}$$

as the share of expenditure allocated to modern sectors, and

$$\eta^M(\tilde{z}) \equiv \frac{\theta(\tilde{z})}{\tilde{z}} \in (0,\infty) \quad \text{and} \quad \eta^T(\tilde{z}) \equiv \frac{1-\theta(\tilde{z})}{1-\tilde{z}} \in (0,\infty) \tag{5}$$

as the sectoral expenditure multipliers, which are defined as expenditure allocated to a specific sector relative to the average expenditure per sector. Following Neary (2003), we assume that all firms within a given sector choose simultaneously between the traditional and the modern technology, and focus on symmetric industry equilibria with $nr^i(\tilde{z}) = p^i(\tilde{z})x^i(\tilde{z}) \;\; \forall \;\; i \in \{T, M\}$. Firm-level revenues can then be written as a function of aggregate expenditure:

$$r^i(\tilde{z}) = \frac{\eta^i(\tilde{z})E(\tilde{z})}{n} \;\; \forall \;\; i \in \{M, T\}\,. \tag{6}$$

Using $\mu^i(\tilde{z}) \in [0,1] \;\; \forall \;\; i \in \{M, T\}$ to denote the sector-level operating margin, we can express firms' profits as:

$$\pi^i(\tilde{z}) = \frac{\mu^i(\tilde{z})\eta^i(\tilde{z})E(\tilde{z})}{n} - I^i w(\tilde{z})F \;\; \forall \;\; i \in \{M, T\}\,, \tag{7}$$

with $I^i \in \{0,1\}$ as an indicator function assuming a value of $I^M = 1$ for $i = M$ and a value of $I^T = 0$ for $i = T$.

Aggregate expenditure equals aggregate income $Y(\tilde{z})$, which in turn is the sum of total profits and aggregate labour income $w(\tilde{z})L$:

$$Y(\tilde{z}) = \tilde{z}n\pi^M(\tilde{z}) + (1-\tilde{z})n\pi^T(\tilde{z}) + w(\tilde{z})L. \tag{8}$$

[8] Exploiting the model's symmetry, we can drop all country-, sector-, and firm-specific indices to save on space and notation.

Substituting $\pi^T(\tilde{z})$ and $\pi^M(\tilde{z})$ from Eq. (7) allows us to write aggregate income as

$$Y(\tilde{z}) = A(\tilde{z})w(\tilde{z})(1 - \tilde{z}nf)L, \tag{9}$$

in which $f \equiv F/L \in (0, 1/n)$, and where

$$A(\tilde{z}) \equiv \frac{1}{1 - \theta(\tilde{z})\mu^M(\tilde{z}) - [1 - \theta(\tilde{z})]\mu^T(\tilde{z})} \geq 1, \tag{10}$$

captures the extent to which production workers' labour income $w(\tilde{z})(1 - \tilde{z}nf)L$ is scaled up through the redistribution of operating profits.

Using the income-expenditure equality again, we substitute $Y(\tilde{z})$ from Eq. (9) into Eq. (7), which allows us to write the profit differential that governs the marginal firm's technology upgrading decision as

$$\pi^M(\tilde{z}) - \pi^T(\tilde{z}) = A(\tilde{z})w(\tilde{z}) \left[\mu^M(\tilde{z})\eta^M(\tilde{z}) - \mu^T(\tilde{z})\eta^T(\tilde{z})(1 - nf) - nf\right] L/n \gtrless 0. \tag{11}$$

Notably, the sign of the inequality, and therefore the upgrading decision of the marginal firm, depends on $\tilde{z}$ only via the operating margins $\mu^i(\tilde{z})$ and the sectoral expenditure shares $\eta^i(\tilde{z})$.

Without loss of generality we fix the number of firms in each country and sector at $n = 1$, such that the variable m not only refers to the number of countries, but also to the number of firms in the global market. Table 1 then summarises firm- and sector-level outcomes. Since the marginal cost of modern firms is lower by a factor $1/\gamma$ in comparison to traditional firms, modern firms set lower prices $p^M(\tilde{z}) < p^T(\tilde{z})$, sell larger quantities $x^M(\tilde{z}) > x^T(\tilde{z})$, and therefore earn larger revenues $r^M(\tilde{z}) > r^T(\tilde{z})$. As a consequence modern firms not only benefit from expenditure diversion towards low-price sectors via $\eta^M(\tilde{z}) > \eta^T(\tilde{z})$ but also from a larger operating margin $\mu^M(\tilde{z}) > \mu^T(\tilde{z})$.

Table 1: *Model Outcomes under Cournot competition*

i	M	T
$p^i(\tilde{z})$	$\frac{1+m\gamma w(\tilde{z})}{1+m}$	$\frac{1+mw(\tilde{z})}{1+m}$
$x^i(\tilde{z})$	$\frac{1-\gamma w(\tilde{z})}{(1+m)}$	$\frac{1-w(\tilde{z})}{(1+m)}$
$r^i(\tilde{z})$	$\frac{[1+m\gamma w(\tilde{z})][1-\gamma w(\tilde{z})]}{(1+m)^2}$	$\frac{[1+mw(\tilde{z})][1-w(\tilde{z})]}{(1+m)^2}$
$\eta^i(\tilde{z})$	$\frac{[1+m\gamma w(\tilde{z})][1-\gamma w(\tilde{z})]}{\tilde{z}[1+m\gamma w(\tilde{z})][1-\gamma w(\tilde{z})]+(1-\tilde{z})[1+mw(\tilde{z})][1-w(\tilde{z})]}$	$\frac{[1+mw(\tilde{z})][1-w(\tilde{z})]}{\tilde{z}[1+m\gamma w(\tilde{z})][1-\gamma w(\tilde{z})]+(1-\tilde{z})[1+mw(\tilde{z})][1-w(\tilde{z})]}$
$\mu^i(\tilde{z})$	$\frac{1-\gamma w(\tilde{z})}{1+m\gamma w(\tilde{z})}$	$\frac{1-w(\tilde{z})}{1+mw(\tilde{z})}$

Conveniently, all variables in Table 1 only depend on model parameters and on the endogenous share $\tilde{z} \in [0, 1]$ of industries using the modern technology. Thereby the wage rate $w(\tilde{z})$ can be obtained from the full employment condition $L = \tilde{z}[\gamma m x^M(\tilde{z}) + F] + (1 - \tilde{z}) m x^T(\tilde{z})$ as

$$w(\tilde{z}) = \frac{1}{\tilde{z}\gamma^2 + 1 - \tilde{z}} \left[(\tilde{z}\gamma + 1 - \tilde{z}) - \frac{1+m}{m}(1 - \tilde{z}f)L \right] \geq 0, \tag{12}$$

in which

$$L < \frac{m}{1+m} \min\left\{1, \frac{\gamma(1-\gamma)}{1 - f - \gamma^2}\right\} \tag{13}$$

is assumed to ensure full employment at positive wages $w(\tilde{z}) > 0$ for all values of $\tilde{z}$.[9]

4 Multiple Equilibria, Poverty Traps, and International Trade

In this section, we first show under which conditions multiple equilibria exist in our model. We then establish a sufficient condition under which the multiplicity of equilibria results in a poverty trap. Finally, it is demonstrated that opening up for free trade does not substitute for a Big Push, that would be necessary to break the vicious circle of poverty.

4.1 Multiple Equilibria in a Global Economy

Proposition 1 summarises the different types of equilibria and establishes a straightforward condition under which a multiplicity of equilibria exists.

Proposition 1 *For $L \geq \bar{L}(m)$ with*

$$\bar{L}(m) \equiv \frac{m}{2[m + \sqrt{2m(1+m)}]},$$

three types of equilibria exist: no industrialisation, complete industrialisation, and incomplete industrialisation. For $L < \bar{L}(m)$ there is in addition a parameter range leading to multiple equilibria, in which the possibilities of complete and incomplete industrialisation co-exist.

Proof See Appendix A.2.

From Eq. (11), the profit gain from modernisation is more likely to be positive if firms using the modern (traditional) technology have (low) operating margins $\mu^i(\tilde{z})$, high (low) sectoral expenditure multipliers $\eta^i(\tilde{z})$, and a sufficiently small fixed labour requirement F. Under the parameter constraint imposed by inequality (13), the wage rate $w(\tilde{z})$ in Eq. (12) is increasing

[9] See Appendix A.1 for a proof. Highly inefficient technologies characterised by $f \geq 1 - \gamma^2$ are excluded to ensure that the right hand side of inequality (13) is positive.

in the share $\tilde{z}$ of modernised sectors.[10] As a consequence, there is a first mover advantage for early adopters, which at low wages $w(\tilde{z}') < w(\tilde{z}'')$ for $\tilde{z}' < \tilde{z}''$ benefit from higher operating margins $\mu^M(\tilde{z}') > \mu^M(\tilde{z}'')$. In addition, by setting lower prices $p^M(\tilde{z}) < p^T(\tilde{z})$ vis-à-vis all traditional firms, modern firms divert expenditure away from their traditional competitors in the sectors $z \in (\tilde{z}, 1]$, which is reflected by $\eta^M(\tilde{z}) > \eta^T(\tilde{z})$. Intuitively, the diversion effect is most pronounced for the first adopters, who offer lower prices vis-à-vis the traditional firms in all other sectors, and therefore experience the largest boost in their sectoral demand. In contrast, the last technology adopters, when upgrading to the modern technology, only match up to all other firms already offering low prices, thereby ensuring that expenditure is (again) allocated equally across all sectors. In summary, pioneering firms benefit from inter-sectoral demand diversion $\eta^M(0) > \eta^M(1)$ as well as from initially high operating margins $\mu^M(0) > \mu^M(1)$. As the modern technology is sequentially adopted by more and more sectors, the marginal firms' incentives for technology adoption are gradually eroded. This explains why, in contrast to the Murphy-Shleifer-Vishny model, partial industrialisation is a possibility in our model. [11]

Multiple equilibria in our setting arise for the same fundamental reason as in Murphy et al. (1989): Firms cannot fully appropriate the returns to their technology investment, which gives rise to a positive pecuniary demand externality, even if the adoption of the modern technology is associated with a loss for the marginal firm in sector $\tilde{z}$. In our model, this externality lies in the modernisation-induced increase in the economy-wide wage rate $w(\tilde{z})$ that shifts out demand for all sectors $z \in [0, 1]$ but is rationally ignored by firms considering the adoption of the modern technology.[12] Whether this effect is strong enough to generate the possibility of multiple equilibria depends on the economy-wide labour supply L relative to the threshold value $\bar{L}(m)$. Intuitively, if L is smaller than $\bar{L}(m)$, labour is scarce relative to the number of firms m in the world market, leading to a steeply increasing wage function $w(\tilde{z})$, and therefore to a sufficiently large wage externality.[13] In this case parameter combinations of f and γ exist

[10]Technology upgrading has two countervailing effects on firms' labour demand and, hence, on the equilibrium wage rate. On the one hand, the introduction of a labour-saving modern technology is associated with a reduction in firms' labour demand at the intensive margin (i.e. per unit of output). On the other hand, we find that, by reducing the marginal cost of production, the modern technology allows firms to lower their price and to expand their production, which increases labour demand at the extensive margin. By imposing condition $L < [m/(1 + m)][\gamma(1 - \gamma)/(1 - f - \gamma^2)]$ we ensure that aggregate demand is sufficiently elastic for the effect at the extensive margin to be dominant.

[11]Following the same logic it can be shown that $\eta^T(0) > \eta^T(1)$ and $\mu^T(0) > \mu^T(1)$ such that the "replacement effect" of technology adoption familiar from Arrow (1962) is smaller for late rather than for early adopters. Reassuringly, we demonstrate in Appendix A.2 that the worsening of firms' outside option is always of second order, such that we have $\pi^M(0) - \pi^T(0) \geq \pi^M(1) - \pi^T(1)$, which inevitably results in an equilibrium with incomplete industrialisation.

[12]By contrast, in the original Murphy-Shleifer-Vishny model the wage rate in the traditional sector is constant, and therefore a sufficiently large exogenous wage premium of modern sectors is needed to generate the corresponding effect.

[13]For a given level of L a higher number m of firms is associated with tougher competition in the world market and lower operating margins $\mu^i(\tilde{z})$. For firms it therefore becomes increasingly difficult to appropriate the returns

that imply multiple equilibria.

Figure 2: *Multiple Equilibria under Cournot Competition*

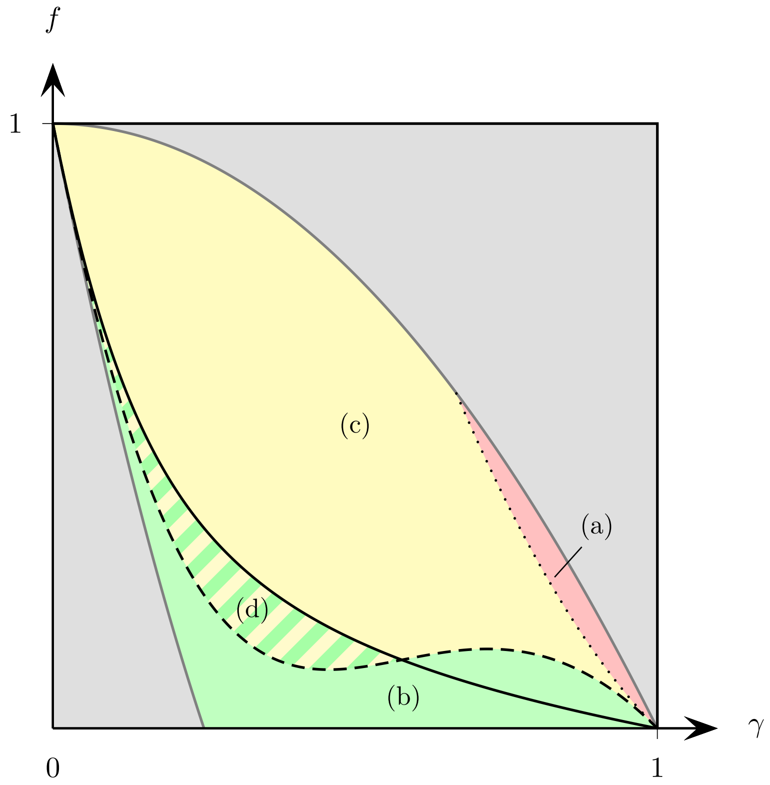


Figure 2 illustrates the different equilibria in technology space. The boundary condition $\pi^M(0) = \pi^T(0)$, represented by the dotted line, separates the red area, in which no firm modernises, from the yellow area, in which the first firm finds it profitable to modernise. Crucial for the existence of multiple equilibria is the relative position of boundary conditions $\pi^M(1) = \pi^T(1)$, represented by the dashed line, and $\pi^M(1) = \pi^T(0)$, represented by the solid line. Boundary condition $\pi^M(1) = \pi^T(1)$ separates the area below (in green), in which it is profitable for each individual sector to modernise, and therefore the modern technology is adopted by all firms, from the area above, in which this is not the case. By contrast, boundary condition $\pi^M(1) = \pi^T(0)$ separates the area below, in which coordinated modernisation of all sectors is profitable, from the area above, in which this is not the case. For parameter combinations in the green and yellow striped area between both boundary conditions, the coordinated modernisation of all sectors is profitable, but the individual modernisation of all sectors is not. Therefore, multiple equilibria exist in this area, with the two possible outcomes being partial modernisation or full modernisation. If L is so large that multiple equilibria are ruled out, boundary condition $\pi^M(1) = \pi^T(0)$

to their technology investments, which means that the positive pecuniary wage externality is more likely to be sufficiently large for a multiplicity of equilibria to arise, and this is why $\bar{L}(m)$ is increasing in m.

lies strictly below boundary condition $\pi^M(1) = \pi^T(1)$, and therefore coordination across sectors cannot be instrumental in achieving full modernisation.[14]

4.2 Multiple Equilibria and Poverty Traps

In the Murphy-Shleifer-Vishny model, the multiplicity of equilibria implies the existence of a poverty trap, since for those parameter combinations that are compatible with multiple equilibria it is always the case that the coordinated equilibrium (full industrialisation) welfare dominates the decentralised equilibrium (no industrialisation). This is different in our model: It is possible that in the multiple equilibria regime of our model the coordinated equilibrium (full industrialisation) is welfare dominated by the decentralised equilibrium (partial industrialisation). However, it is possible to provide a sufficient condition for the coordinated equilibrium to welfare dominate the decentralised equilibrium in all cases that give rise to multiple equilibria.

Proposition 2 *Under the sufficient condition $L \in (\underline{L}(m), \bar{L}(m))$, where $\underline{L}(m)$ is plotted together with $\bar{L}(m)$ in Figure 3, full industrialisation is welfare superior to partial industrialisation, and therefore every regime featuring multiple equilibria constitutes a poverty trap.*

Proof See Appendix A.3.

Intuitively, we show in the proof that under the parameter constraint given in Proposition 2 indirect utility

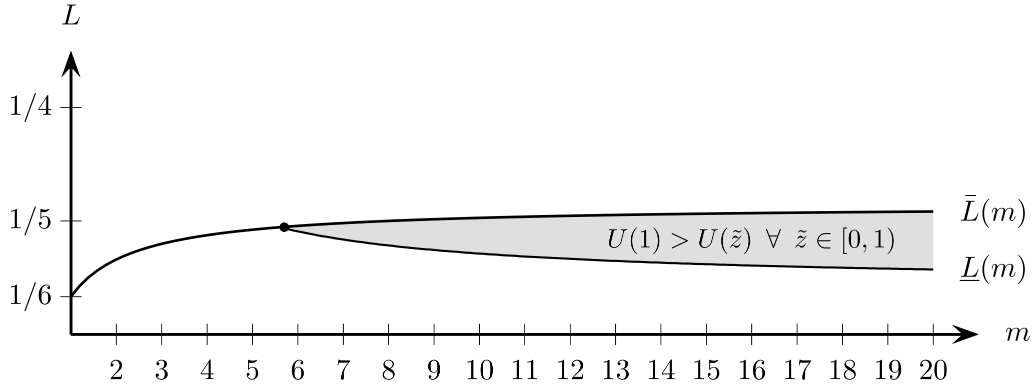
$$U(\tilde{z}) = \frac{1}{2}\left\{1 - \frac{[\int_0^{\tilde{z}} p^M(\tilde{z})dz + \int_{\tilde{z}}^1 p^T(\tilde{z})dz - Y(\tilde{z})]^2}{\int_0^{\tilde{z}}[p^M(\tilde{z})]^2 dz + \int_{\tilde{z}}^1 [p^T(\tilde{z})]^2 dz}\right\} \tag{14}$$

increases monotonically in $\tilde{z}$, and therefore any equilibrium with full industrialisation welfare dominates any equilibrium with partial industrialisation. As in the Murphy-Shleifer-Vishny model, it is always true in our model that full industrialisation ($\tilde{z} = 1$) welfare dominates a situation with no industrialisation ($\tilde{z} = 0$), as long as $f + \gamma < 1$. But in general $U(\tilde{z})$ can have an interior maximum in our model, and welfare in an equilibrium with complete industrialisation may then be surpassed by welfare in an equilibrium with incomplete industrialisation, such that $U(1) < U(\tilde{z})$ for some values of $\tilde{z} \in (0, 1)$. It is this case that our parameter constraint excludes.

To understand where the (potential) non-monotonicity in welfare $U(\tilde{z})$ originates from, it is important to note that improvements in the average technology level are not the sole reason for consumers' welfare gains. The gradual adoption of the modern technology by more and more sectors is also accompanied by a welfare-relevant change in the dispersion of technology

[14] An interactive version of Figure 2 is available from the authors upon request as a Computable Data File (CDF), which can be used in combination with Wolfram's CDF-player (available as a free download under: www.wolfram.com/cdf-player/.)

Figure 3: *Technology Upgrading and Aggregate Welfare*



levels across sectors. In particular, it is shown by Neary (2016) that a mean-preserving spread in an economy's technology distribution is associated with a higher level of welfare as it allows consumers to substitute towards relatively less costly products. Due to the binary technology choice in our model, the variance $\sigma^2(\tilde{z}) = \tilde{z}(1-\tilde{z})(1-\gamma)^2 \geq 0$ of the technology levels γ takes the particular simple form of an inverted U, with a unique maximum at $\tilde{z}_{\max} = 1/2$ and values of $\sigma^2(0) = \sigma^2(1) = 0$ if the modern technology is adopted either by all sectors or not at all. If aggregate welfare is sufficiently sensitive to the dispersion of technology levels, the inverted U-shape in $\sigma^2(\tilde{z})$ carries over to $U(\tilde{z})$.

4.3 Poverty Traps and International Trade

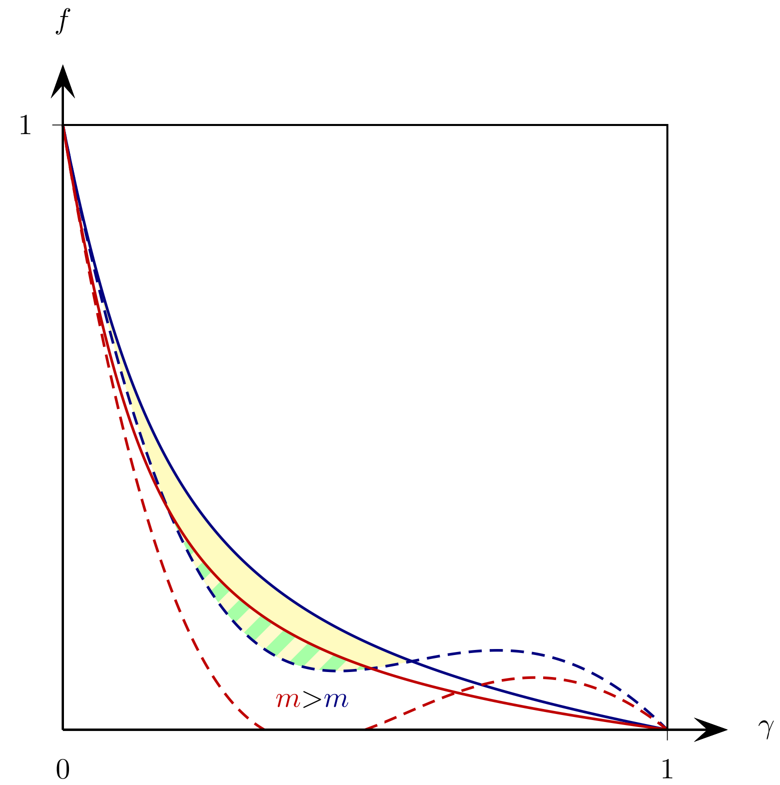
We now analyse the effect of international trade on an economy that is caught in a poverty trap, focussing on the case, in line with Proposition 2, that $L \in (\underline{L}(m), \bar{L}(m))$. An increase in the level of international trade is modelled in the simplest possible way as an increase in the number of trading countries m. We get the following result:

Proposition 3 *An economy cannot escape from a poverty trap by opening up to free international trade with more partner countries.*

Proof See Appendix A.4.

Intuitively, an important explanation for our strong result lies in the fact that the fundamentals of our model are completely symmetric across sectors and countries, and therefore the resource allocation in any economy with identical industry equilibria (e.g. with no industrialisation or with complete industrialisation) is socially efficient, and does not depend on the number of firms or the size of their mark-ups (cf. Lerner, 1934). The sole impact of opening up for international trade in such a setting is to enhance competition, which alters the distribution of constant (total) industry rents to the disadvantage of firms, which now face a more competitive environment with lower operating margins.

Figure 4: *Multiple Equilibria and International Trade*



The result stated in Proposition 3 is further illustrated in Figure 4, which replicates in blue the two boundary conditions $\pi^M(1) = \pi^T(1)$ and $\pi^M(1) = \pi^T(0)$ from Figure 2, enclosing the area of multiple equilibria. As we show in Appendix A.4, an increase in m shifts both boundary condition down, and the post-change boundaries are given in red. As a result, there are now parameter combinations, shown in Figure 4 as the yellow shaded area, for which full industrialisation is no longer a possibility, even if the sectors were able to coordinate. In addition, in the area between the blue and red dashed boundary conditions, there is the newly arising possibility of a poverty trap, since the respective combinations of f and γ are now in the area of multiple equilibria, while before the increase in m the only stable equilibrium was one with full industrialisation.

As suggested above, the strongly negative result about the role of international trade in Proposition 3 would be potentially mitigated if country asymmetries allowed for some gains from trade. In order to illustrate this point, we briefly sketch an asymmetric version of our model.

For simplicity and in order to maintain the model's basic symmetry we focus on the specific example of a two-country world in which Home has a comparative advantage in all industries indexed between 0 and 1/2 on the unit interval (modelled through symmetric variable labour input coefficients $\delta < 1$), while the comparative advantage of Foreign lies in the production of goods which are indexed by values between 1/2 and 1 (again modelled through symmetric variable labour input coefficients $\delta < 1$). Intuitively, if δ is sufficiently small, the free trade equilibrium is characterised by complete specialisation as in Dornbusch et al. (1977). For the surviving firms a shift from autarky to free trade then is tantamount to an (exogenous) increase in market size, which makes it easier to escape from any pre-existing poverty trap. Notably, the unambiguously positive impact of international trade here is derived in the absence of a pro-competitive trade effect, given that the surviving firms do not have to fear any competition from abroad. For more general productivity distributions as for example discussed by Neary (2016) there always exists a "cone of diversification" in which firms from both countries can coexist under oligopolistic competition. The link between international trade and technology upgrading then depends on whether the respective firm stems from a sector with comparative advantage or comparative disadvantage. Advantaged firms gain market shares, which potentially compensate for a tougher competition through international trade. Disadvantaged firms on the contrary suffer from the loss of market shares and from the more intense competition in the global market. Since disadvantaged firms are also likely candidates for a late adoption of the modern technology, there is a fair chance that a pre-existing poverty trap gets aggravated through international trade.

5 Conclusion

By incorporating a binary technology choice into a General Oligopolistic Equilibrium (GOLE) with Cournot competition, we demonstrate the existence of poverty traps in a global economy. Thereby, our model not only refutes the popular misconception, that in an open economy insufficient (initial) market size becomes meaningless as an argument for economies to be trapped in low-income equilibria – as even the world market might turn out to be initially too small to support the decentralised adoption of a socially optimal technology. We also demonstrate that with variable mark-ups it is possible to (endogenously) generate a poverty trap without the assumption of an exogenously given wage premium as in Murphy et al. (1989).

Within our more general framework three possible equilibrium types exist. As in the original Big Push model, our economy may end up in one of two polar cases, featuring either no or complete industrialisation. However, in addition there also is an equilibrium with incomplete industrialisation, in which the modern technology is adopted by firms in some, yet not in all, industries. We show that there exist parameter combinations for which our model features a multiplicity of equilibria, characterised by incomplete versus complete industrialisation. Thereby, the rationale for a poverty trap is the same as in Murphy et al. (1989): Firms rationally ignore the pecuniary demand externality that in our model arises from endogenously increasing wages, and they therefore under-invest in the adoption of the modern technology in a decentralised market equilibrium. Since international trade in an environment with variable mark-ups is associated with a pro-competitive effect, firms face shrinking operating margins, which limits their ability to appropriate the returns from technology upgrading, thereby aggravating the underinvestment problem and reinforcing the vicious circle of poverty.

References

Arrow, K. (1962): "Economic Welfare and the Allocation of Resources for Invention," in *The Rate and Direction of Inventive Activity: Economic and Social Factors*, National Bureau of Economic Research, Inc, NBER Chapters, 609–26.

Azariadis, C. and J. Stachurski (2005): "Chapter 5 Poverty Traps," Elsevier, vol. 1, Part A of *Handbook of Economic Growth*, 295–384.

Bandyopadhyay, S. (1997): "Demand Elasticities, Asymmetry and Strategic Trade Policy," *Journal of International Economics*, 42, 167–77.

Bastos, P. and U. Kreickemeier (2009): "Unions, Competition and International Trade in General Equilibrium," *Journal of International Economics*, 79, 238–47.

Bastos, P. and O. R. Straume (2012): "Globalization, Product Differentiation, and Wage Inequality," *Canadian Journal of Economics*, 45, 857–78.

Bjorvatn, K. and N. D. Coniglio (2012): "Big Push or Big Failure? On the Effectiveness of Industrialization Policies for Economic Development," *Journal of the Japanese and International Economies*, 26, 129–41.

Chenery, H., S. Robinson, and M. Syrquin (1986): *Industrialization and Growth: A Comparative Study*, Washington D.C.: The Worldbank.

Chenery, H. and M. Syrquin (1975): *Patterns of Development, 1950-1970*, Washington D.C.: The Worldbank.

Ciccone, A. (2002): "Input Chains and Industrialization," *The Review of Economic Studies*, 69, 565–87.

Colacicco, R. (2015): "Ten Years Of General Oligopolistic Equilibrium: A Survey," *Journal of Economic Surveys*, 29, 965–92.

Dornbusch, R., S. Fischer, and P. A. Samuelson (1977): "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods," *The American Economic Review*, 67, 823–39.

Eckel, C., L. Iacovone, B. Javorcik, and J. P. Neary (2015): "Multi-product Firms at Home and Away: Cost- versus Quality-based Competence," *Journal of International Economics*, 95, 216–32.

Eckel, C. and J. P. Neary (2010): "Multi-Product Firms and Flexible Manufacturing in the Global Economy," *The Review of Economic Studies*, 77, 188–217.

Egger, H. and D. Etzel (2012): "The Impact of Trade on Employment, Welfare, and Income Distribution in Unionized General Oligopolistic Equilibrium," *European Economic Review*, 56, 1119–35.

Egger, H. and M. Koch (2012): "Labour Unions and Multi-product Firms in Closed and Open Economies," *Canadian Journal of Economics*, 45, 1456–79.

Egger, H., F. Meland, and H.-J. Schmerer (2015): "Differences in the Degree of Unionization as a Source of Comparative Advantage in Open Economies," *Canadian Journal of Economics*, 48, 245–72.

Ethier, W. J. (1982): "National and International Returns to Scale in the Modern Theory of International Trade," *American Economic Review*, 72, 389–405.

Fleming, M. (1955): "External Economies and the Doctrine of Balanced Growth," *The Economic Journal*, 65, 241–56.

Gans, J. S. (1997): "Fixed Cost Assumptions in Industrialisation Theories," *Economics Letters*, 56, 111–19.

Gorman, W. M. (1961): "On a Class of Preference Fields," *Metroeconomica*, 13, 53–6.

Head, K. and T. Mayer (2013): "What Separates Us? Sources of Resistance to Globalization," *Canadian Journal of Economics*, 46, 1196–231.

Kraay, A. and D. McKenzie (2014): "Do Poverty Traps Exist? Assessing the Evidence," *Journal of Economic Perspectives*, 28, 127–48.

Kreickemeier, U. and F. Meland (2013): "Non-traded Goods, Globalization and Union Influence," *Economica*, 80, 774–92.

Krugman, P. R. (1991): "Increasing Returns and Economic Geography," *Journal of Political Economy*, 99, 483–499.

——— (1993): "Toward a Counter-Counterrevolution in Development Theory," Proceedings of the World Bank Annual Conference on Development Economics 1992.

Krugman, P. R. and R. L. Elizondo (1996): "Trade Policy and the Third World Metropolis," *Journal of Development Economics*, 49, 137–50.

Lerner, A. P. (1934): "The Concept of Monopoly and the Measurement of Monopoly Power," *The Review of Economic Studies*, 1, 157–75.

Matsuyama, K. (1991): "Increasing Returns, Industrialization, and Indeterminacy of Equilibrium," *The Quarterly Journal of Economics*, 106, 617–50.

——— (1992): "The Market Size, Entrepreneurship, and the Big Push," *Journal of the Japanese and International Economies*, 6, 347–64.

——— (2008): "Poverty Traps," in *The New Palgrave Dictionary of Economics*, ed. by S. N. Durlauf and L. E. Blume, Palgrave Macmillan, 2. ed.

Mehlum, H., K. Moene, and R. Torvik (2003): "Predator or Prey?: Parasitic Enterprises in Economic Development," *European Economic Review*, 47, 275–94.

Murphy, K. M., A. Shleifer, and R. W. Vishny (1989): "Industrialization and the Big Push," *Journal of Political Economy*, 97, 1003–26.

Neary, J. P. (2003): "Globalization and Market Structure," *Journal of the European Economic Association*, 1, 245–271.

——— (2007): "Cross-Border Mergers as Instruments of Comparative Advantage," *The Review of Economic Studies*, 74, 1229–57.

——— (2016): "International Trade in General Oligopolistic Equilibrium," *Review of International Economics*, 24, 669–698.

Neary, J. P. and D. Leahy (2015): "When the Threat Is Stronger than the Execution: Trade Liberalization and Welfare Under Oligopoly," Economics Series Working Papers 775, University of Oxford, Department of Economics.

Neary, J. P. and J. Tharakan (2012): "International Trade with Endogenous Mode of Competition in General Equilibrium," *Journal of International Economics*, 86, 118–32.

Nurkse, R. (1952): "Some International Aspects of the Problem of Economic Development," *The American Economic Review*, 42, 571–83.

Paternostro, S. (1997): "The Poverty Trap: The Dual Externality Model and Its Policy Implications," *World Development*, 25, 2071–81.

Rosenstein-Rodan, P. N. (1943): "Problems of Industrialisation of Eastern and South-Eastern Europe," *The Economic Journal*, 53, 202–11.

Sachs, J. D. and A. M. Warner (1999): "The Big Push, Natural Resource Booms and Growth," *Journal of Development Economics*, 59, 43–76.

Stiglitz, J. E. (1993): "Comment on 'Toward a Counter-Counterrevolution in Development Theory'," Proceedings of the World Bank Annual Conference on Development Economics 1992.

Trindade, V. (2005): "The Big Push, Industrialization and International Trade: The Role of Exports," *Journal of Development Economics*, 78, 22–48.

Yamada, M. (1999): "Specialization and the Big Push," *Economics Letters*, 64, 249–55.

A Appendix

Some of the proofs contained in this Appendix require tedious transformations. To make it easier for the interested reader to check the correctness of these intermediate steps, all computations have been implemented in Mathematica. A Computable Data File (CDF), which can be used in combination with Wolfram's CDF-player (available as free download under: www.wolfram.com/cdf-player/), can be obtained from the authors upon request.

A.1 Derivation of Eq. (13)

We assume $L < m/(1+m)$, which ensures $w(0) > 0$ as well as $L < [m/(1+m)](1-\gamma)/\{[(1-f)/\gamma] - \gamma\}$, which guarantees that $w'(\tilde{z}) > 0$. Together, we have $L < [m/(1+m)]\min\{1, (1-$

$\gamma)/([(1-f)/\gamma]-\gamma)\}$. As we assume $L < m/(1+m)$ to hold throughout, we have to ensure that

$$f > g(\gamma) = g(\gamma; m, L) \equiv \frac{(1-\gamma)[(1+m)(1+\gamma) - m\gamma/L]}{(1+m)}, \tag{A.1}$$

which is equivalent to $L < [m/(1+m)](1-\gamma)/([(1-f)/\gamma]-\gamma)$. ■

A.2 Proof of Proposition 1

Substituting $Y(\tilde{z})$ from Eq. (9) back into $\pi^T(\tilde{z})$ and $\pi^M(\tilde{z})$ from Eq. (7) yields

$$\pi^T(0) = \frac{1-w(0)}{1+m}L \quad \text{and} \quad \pi^T(1) = \frac{[1-w(1)]^2}{(1+m)[1-\gamma w(1)]}\frac{L-F}{\gamma}, \tag{A.2}$$

as well as

$$\pi^M(0) = \frac{[1-\gamma w(0)]^2}{(1+m)[1-w(0)]}L - w(0)F \quad \text{and} \quad \pi^M(1) = \frac{1-\gamma w(1)}{1+m}\frac{L-F}{\gamma} - w(1)F, \tag{A.3}$$

which are evaluated at $\tilde{z}=0$ and $\tilde{z}=1$, respectively. Substituting $w(0)$ from Eq. (12) into $\pi^M(0)$ and $\pi^T(0)$ from Eqs. (A.3) and (A.2) allows us to solve for

$$f_F(\gamma) = f_F(\gamma; m, L) \equiv \frac{(1+m)(1-\gamma^2) + (1-\gamma)^2 m/L}{(1+m)^2}, \tag{A.4}$$

with $f_F(\gamma) <=> f$ being equivalent to $\pi^M(0) <=> \pi^T(0)$. Substituting $w(1)$ from Eq. (12) into $\pi^M(1)$ and $\pi^T(1)$ from Eqs. (A.3) and (A.2) allows us to solve for

$$f_L(\gamma) = f_L(\gamma; m, L) \equiv \frac{(1+m)(1-\gamma^2) - \gamma(1-\gamma)^2 m/L}{(1+m)(1+m\gamma^2)}, \tag{A.5}$$

with $f_L(\gamma) <=> f$ being equivalent to $\pi^M(1) <=> \pi^T(1)$. Finally, substituting $w(0)$ and $w(1)$ from Eq. (12) into $\pi^M(1)$ and $\pi^T(0)$ from Eqs. (A.3) and (A.2) allows us to solve for

$$f_C(\gamma) = f_C(\gamma; m, L) \equiv \frac{\sqrt{(1+m)^2 - 2m(m-1)\gamma/L - m(4-m/L^2)\gamma^2} + m(1-\gamma/L) - 1}{2m}, \tag{A.6}$$

with $f_C(\gamma) <=> f$ being equivalent to $\pi^M(1) <=> \pi^T(0)$.

At first, we show that for the relevant parameter space $f_F(\gamma) \geq \max\{f_L(\gamma), f_C(\gamma)\}$. For this purpose it is convenient to consider the cases $L \geq 1/(1+m)$ and $L < 1/(1+m)$ separately. For $L < 1/(1+m)$ the functions $f_F(\gamma)$ and $f_L(\gamma)$ have a single intersection point in $\gamma \in [0,1]$ at $\gamma = 1$. The same holds true for the functions $f_F(\gamma)$ and $f_C(\gamma)$. Moreover, we have $f_F(0) = (1+m+m/L)/(1+m)^2 > 1 = f_L(0) = f_C(0)$, which implies that we have $f_F(\gamma) \geq \max\{f_L(\gamma), f_C(\gamma)\}$ for the relevant parameter space $\gamma \in [0,1]$. Turning to the parameter range $L \geq 1/(1+m)$, we find that in addition to $f_F(1) = f_L(1) = f_C(1) = 0$ there is a second intersection point at $\gamma_0(m,L) = [1-(1+m)L]/[L-(1-L)m] \in [0,1]$ and $f_F(\gamma_0(m,L)) = f_L(\gamma_0(m,L)) = f_C(\gamma_0(m,L)) = g(\gamma_0(m,L)) = (1-2L)/L[(1-L)m-L] \leq 1$ for $1/(1+m) \leq L < 1/2$. Finally, taking into account $f'_F(1) = f'_L(1)$, $f''_F(1) > f''_L(1)$, and $f'_F(1) < f'_C(1)$, we have $f_F(\gamma) \geq \max\{f_L(\gamma), f_C(\gamma)\}$ for the relevant parameter space $\gamma \in [\gamma_0(m,L),1]$ with $\gamma_0(m,L) \in [0,1]$.

In the next step we establish that $f_C(\gamma)$ and $f_L(\gamma)$ intersect twice in $\gamma \in (\max\{0,\gamma_0(m,L)\},1)$ if and only if $L < \bar{L}(m)$ with

$$\bar{L}(m) \equiv \frac{m}{2[m+\sqrt{2m(1+m)}]}. \tag{A.7}$$

Note that $f_C(\gamma)$ and $f_L(\gamma)$ intersect at most five times. In addition to the intersection points at $\gamma = 0$ and $\gamma = 1$, we have $\gamma_0(m,L) = [1-L(1+m)]/[L-(1-L)m]$ as well as

$$\gamma_1(m,L) = \frac{m(m-1)-(1+m)\sqrt{m[m-4mL-4(2+m)L^2]}}{2m[m+(1+m)L]}, \tag{A.8}$$

$$\gamma_2(m,L) = \frac{m(m-1)+(1+m)\sqrt{m[m-4mL-4(2+m)L^2]}}{2m[m+(1+m)L]}, \tag{A.9}$$

with $\gamma_1(m,L) \leq \gamma_2(m,L) \;\; \forall \;\; L \in (0,\bar{L}(m)]$. For $\gamma_1(m,L)$ and $\gamma_2(m,L)$ to exist, the discriminant in both expressions has to be non-negative, which is the case for $L \leq \bar{L}(m)$. Note that for $L = \bar{L}(m)$ we have $\gamma_1(m,L) = \gamma_2(m,L)$, which correspond to a tangency point between $f_C(\gamma)$ and $f_L(\gamma)$. Finally, using the solution for $\gamma_1(m,L)$ and $\gamma_2(m,L)$, it can be shown that $\gamma_1(m,L) \in (\gamma_0(m,L),1)$ and that $\gamma_2(m,L) \in (\max\{0,\gamma_0(m,L)\},1)$.

In the last step we establish that $g(\gamma) \leq \min\{f_L(\gamma), f_C(\gamma)\}$. Again it is helpful to consider the cases $L \geq 1/(1+m)$ and $L < 1/(1+m)$ separately. For $L < 1/(1+m)$ the functions $g(\gamma)$ and $f_L(\gamma)$ as well as the functions $g(\gamma)$ and $f_C(\gamma)$ intersect twice in $\gamma \in [0,1]$ at $\gamma = 0$ and $\gamma = 1$. Thereby, $g'(1) > f'_L(1)$ and $g'(1) >, f'_C(1)$ guarantee that $g(\gamma) \leq \min\{f_L(\gamma), f_C(\gamma)\} \;\; \forall \;\; \gamma \in [0,1]$ if $L < 1/(1+m)$. For $L \geq 1/(1+m)$ we focus on the relevant parameter space $\gamma \in [\gamma_0(m,L),1]$ and find that the functions $g(\gamma)$ and $f_L(\gamma)$ as well as the functions $g(\gamma)$ and $f_C(\gamma)$ intersect twice in $\gamma \in [\gamma_0(m,L),1]$ at $\gamma = \gamma_0(m,L)$ and $\gamma = 1$. Again, $g'(1) > f'_L(1)$ and $g'(1) > f'_C(1)$ guarantee that $g(\gamma) \leq \min\{f_L(\gamma), f_C(\gamma)\} \;\; \forall \;\; \gamma \in [\gamma_0(m,L),1]$ if $L \geq 1/(1+m)$. ■

A.3 Proof of Proposition 2

Before analysing internal solutions of $U(\tilde{z})$ for $\tilde{z} \in (0,1)$, we focus on the corner solutions at $\tilde{z} = 0$ and $\tilde{z} = 1$. In an equilibrium in which the modern technology is adopted either by no firm (i.e. $\tilde{z}=0$) or by all firms (i.e. $\tilde{z}=1$), we have $p(z)=p(0)$ and, $p(z)=p(1)$, respectively. It follows from Eq. (14) that indirect utility only depends on real income, such that $\widetilde{U}(1)>\widetilde{U}(0)$ may equivalently expressed as $[Y(1)/p^M(1)]/[Y(0)/p^T(0)] = x^M(1)/x^T(0) = (1-f)/\gamma > 1$. Thus, for the relevant parameter space $f<1-\gamma$ we have $U(1)>U(0)$.

We now consider $U(\tilde{z})$ for $\tilde{z}\in(0,1)$. Using $p^M(\tilde{z})\ \forall\ z\in[0,\tilde{z})$ and $p^T(\tilde{z})\ \forall\ z\in[\tilde{z},1]$ from Table 1 together with $w(\tilde{z})$ from Eq. (12) in Eq. (14) allows us to derive

$$U(\tilde{z})=\frac{L(1-\tilde{z}f)\{2[1-(1-\gamma)\tilde{z}]-L(1-\tilde{z}f)\}}{2[1-(1-\gamma^2)\tilde{z}]}+\frac{m(2+m)(1-\gamma)^2(1-\tilde{z})\tilde{z}}{2(1+m)^2[1-(1-\gamma^2)\tilde{z}]}. \tag{A.10}$$

In the following we demonstrate that $U(\tilde{z})$ has at most one extremum in $\tilde{z}\in(0,1)$, which is a maximum. Note that $U'(\tilde{z})=0$ has two solutions at $\tilde{z}_1=(1-\gamma\Gamma)/(1-\gamma^2)$ and $\tilde{z}_2=(1+\gamma\Gamma)/(1-\gamma^2)$, with $\Gamma\equiv\sqrt{\Gamma_1\Gamma_2}\in(0,1)$ and

$$\Gamma_1\equiv\frac{m(1-\gamma)-(1+m)\{[(1-f)/\gamma]-\gamma\}L}{m(1-\gamma)-(1+m)fL}\in(0,1), \tag{A.11}$$

$$\Gamma_2\equiv\frac{(2+m)(1-\gamma)-(1+m)\{[(1-f)/\gamma]-\gamma\}L}{(2+m)(1-\gamma)-(1+m)fL}\in(0,1), \tag{A.12}$$

for $L>[(2+m)/(1+m)](1-\gamma)/f$. Since $\tilde{z}_2>1$, there exists at most one extremum in $\tilde{z}\in(0,1)$. We now demonstrate, that if the extremum $\tilde{z}_1$ falls into the relevant parameter space $\tilde{z}\in(0,1)$, it has to be a maximum. Note that $\lim_{\tilde{z}\to 0}U'(\tilde{z})>0$ may be equivalently stated as $f<f_U^0(\gamma)$ with

$$f_U^0(\gamma)\equiv\frac{(1-\gamma)[2(1+m)^2L\gamma+m(2+m)(1-\gamma)-(1+m)^2L^2(1+\gamma)]}{2(1+m)^2L(1-L)}. \tag{A.13}$$

It is easily verified that $f_U^0(\gamma)\geq f_F(\gamma)\ \forall\ \gamma\in(0,1)$ if $L<\bar{L}(m)$. Since $f\leq f_F(\gamma)$ is a necessary condition for multiple equilibria to exist, we know that for the relevant parameter set $\lim_{\tilde{z}\to 0}U'(\tilde{z})>0$ has to hold. Moreover, we know from above that $U(1)>U(0)$ for $f<1-\gamma$, such that we can safely conclude that if $\tilde{z}_1$ falls into the relevant parameter space $\tilde{z}\in(0,1)$, it has to be a maximum.

Finally, to complete the proof, we formulate a sufficient condition for $\tilde{z}_1\geq 1$, such that $U(1)\geq U(\tilde{z})\ \forall\ \tilde{z}\in[0,1]$. Note that $\tilde{z}_1\geq 1$ if $\gamma\leq\Gamma$, which may equivalently expressed as $f\leq f_U(\gamma)$ with

$$\begin{aligned}f_U(\gamma)\equiv&\frac{L-\gamma(1-\gamma+\gamma^2)}{L(1+\gamma^2)}\\&+\frac{\gamma\sqrt{1+\gamma\{\gamma[3-2(1+m)^2L+(1+m)^2L^2+m(2+m)-(2-\gamma)\gamma]-2\}}}{(1+m)L(1+\gamma^2)}.\end{aligned} \tag{A.14}$$

It follows from the inspection of $f'_U(\gamma)$ that $f_U(\gamma)$ has at most three extrema. Accounting for $f_U(0) = 1 > f_U(1) = 0$ as well as for $f'_U(0) < 0$ and $f'_U(1) < 0$, it becomes clear that at most two of these three extrema can fall into the parameter range $\gamma \in (0,1)$. From above we know that $f_C(0) = 1 > f_C(1) = 0$, and that $f'_C(\gamma) < 0 < f'_C(\gamma)\ \forall\ \gamma \in [0,1]$. Furthermore, we have $f'_U(1) < f''_C(1)$ as well as $f'_U(0) = f'_C(0)$ and $f''_U(0) > f''_C(0)\ \forall\ L \in (1/(m+1), m/(m+1))$. Hence, if there is a solution $\underline{L}(m)$ to the system of equations $f_U(\gamma^*(L,m)) = f_C(\gamma^*(L,m))$ and $f'_U(\gamma^*(L,m)) = f'_C(\gamma^*(L,m))$, there exists a unique tangency point $\gamma^*(L,m)$ between $f_U(\gamma)$ and $f_C(\gamma)$, implying $f_U(\gamma) \geq f_C(\gamma)\ \forall\ \gamma \in [0,1]$. We plot $\underline{L}(m)$ in Figure 3, and it is easily verified that $\bar{L}(m), \underline{L}(m) \in (1/(1+m), m/(1+m))$. ■

A.4 Proof of Proposition 3

Focussing only on parameter values for which multiple equilibria exist (e.g. $L < \bar{L}(m)$), we show that an increase in the number of trading partners m does not result in a transition from an equilibrium with incomplete industrialisation to an equilibrium with complete industrialisation. Inspecting Figure 4 and recalling the definition of $f_L(\gamma; m, L)$ and $f_C(\gamma; m, L)$ from Eqs. (A.5) and (A.6), it is clear that starting out from a multiplicity of equilibria an increase in m does not cause a transition from an equilibrium with incomplete industrialisation to an equilibrium with complete industrialisation if $f_L(\gamma; m, L)$ and $f_C(\gamma; m, L)$ are both weakly decreasing in m.

At, first we establish $\partial f_C(\gamma; m, L)/\partial m \leq 0\ \forall\ \gamma \in (0,1)$. It can be shown that $\partial f_C(\gamma; m, L)/\partial m > 0\ \forall\ \gamma \in (0,1)$ is incompatible with $L \in (0, \bar{L}(m))$. Due to proof by contradiction, it hence follows that $f_C(\gamma; m, L)$ is weakly decreasing in m for all $\gamma \in (0,1)$.

We now turn to $f_L(\gamma; m, L)$. Let us define $L_0(m) \equiv (3 - 2\sqrt{2})m/(m+1) \in (0, \bar{L}(m))$. Then for $L \in (0, L_0(m))$, the function $f_L(\gamma; m, L)$ has two intersection points with the abscissa at

$$\gamma_1^0(m, L) \equiv \frac{m - (1+m)L - \sqrt{[(1+m)L - m]^2 - 4m(1+m)L}}{2m} \in (0,1), \tag{A.15}$$

$$\gamma_2^0(m, L) \equiv \frac{m - (1+m)L + \sqrt{[(1+m)L - m]^2 - 4m(1+m)L}}{2m} \in (0,1), \tag{A.16}$$

with $\gamma_1^0(m, L) \leq \gamma_2^0(m, L)\ \forall\ L \in (0, L_0(m)]$. At $L = L_0(m)$ the function $f_L(\gamma; m, L)$ has a unique tangency point at $\gamma_1^0(m, L_0(m)) = \gamma_2^0(m, L_0(m)) = [m - (1+m)L]/2m$. Finally, for $L \in (L_0(m), \bar{L}(m))$ we have $f_L(\gamma; m, L) > 0\ \forall\ \gamma \in [0,1)$ and $f_L(\gamma; m, L)|_{\gamma=1} = 0$. It is easily verified that $\partial f_L(\gamma; m, L)/\partial m > 0\ \forall\ \gamma \in (0,1)$ is incompatible with $L \in [L_0(m), \bar{L}(m))$. It hence follows that $f_L(\gamma; m, L)$ is weakly decreasing in m for all $\gamma \in (0,1)$ as long as $L \in [L_0(m), \bar{L}(m))$. For the parameter range $L \in [L_0(m), \bar{L}(m))$ an increase in m hence is associated with a downward shift in $f_C(\gamma; m, L)$ and $f_L(\gamma; m, L)$. As a consequence, we find that parameter combinations of

γ and f, which *ex ante* to the increase in m were associated with a multiplicity of equilibria, i.e. $\pi^M(0) > \pi^T(0) \ \wedge \ \pi^M(1) < \pi^T(1) \ \wedge \ \pi^M(1) > \pi^T(0)$, are *ex post* to the increase in m associated with one of three possible equilibria types: a unique equilibrium characterised by no industrialisation, i.e. $\pi^M(0) < \pi^T(0) \ \wedge \ \pi^M(1) < \pi^T(1) \ \wedge \ \pi^M(1) < \pi^T(0)$, a unique equilibrium characterised by incomplete industrialisation, i.e. $\pi^M(0) > \pi^T(0) \ \wedge \ \pi^M(1) < \pi^T(1) \ \wedge \ \pi^M(1) < \pi^T(0)$, or (as before) by a multiplicity of equilibria with $\pi^M(0) > \pi^T(0) \ \wedge \ \pi^M(1) < \pi^T(1) \ \wedge \ \pi^M(1) > \pi^T(0)$.

We now turn to the parameter range $L \in (0, L_0(m))$. Let us define $\hat{L}(m) \equiv m/[2 + m(3 + m)] \in (0, L_0(m))$, such that $L <=> \hat{L}(m)$ is equivalent to $\gamma_1(m, L) <=> 0$. It is easily verified that $\partial f_L(\gamma; m, L)/\partial m > 0 \ \forall \ \gamma \in (0, \gamma_1(m, L)]$ is incompatible with $L \in (\hat{L}(m), L_0(m))$. It hence follows that $f_L(\gamma; m, L)$ is weakly decreasing in m for all $\gamma \in (0, \gamma_1(m, L)]$. Taking into account that $\partial f_C(\gamma; m, L)/\partial m < 0$ implies that $f_L(\gamma; m, L)|_{\gamma=\gamma_1(m,L)} = f_C(\gamma; m, L)|_{\gamma=\gamma_1(m,L)}$ declines in m. Note that $\partial\gamma_2(m, L)/\partial m \leq 0$ is incompatible with $L \in (0, L_0(m))$. Taking into account $\partial f_C(\gamma; m, L)/\partial m < 0$ and $\partial f_C(\gamma; m, L)/\partial\gamma < 0$, it follows that $f_L(\gamma; m, L)|_{\gamma=\gamma_2(m,L)} = f_C(\gamma; m, L)|_{\gamma=\gamma_2(m,L)}$ declines in m. Finally, given that $\partial f_C(\gamma; m, L)/\partial m < 0$, we find that parameter combinations of γ and f, which *ex ante* to the increase in m were associated with a multiplicity of equilibria, i.e. $\pi^M(0) > \pi^T(0) \ \wedge \ \pi^M(1) < \pi^T(1) \ \wedge \ \pi^M(1) > \pi^T(0)$, are *ex post* to the increase in m associated with one of three possible equilibria types: a unique equilibrium characterised by no industrialisation, i.e. $\pi^M(0) < \pi^T(0) \ \wedge \ \pi^M(1) < \pi^T(1) \ \wedge \ \pi^M(1) < \pi^T(0)$, a unique equilibrium characterised by incomplete industrialisation, i.e. $\pi^M(0) > \pi^T(0) \ \wedge \ \pi^M(1) < \pi^T(1) \ \wedge \ \pi^M(1) < \pi^T(0)$, or (as before) by a multiplicity of equilibria with $\pi^M(0) > \pi^T(0) \ \wedge \ \pi^M(1) < \pi^T(1) \ \wedge \ \pi^M(1) > \pi^T(0)$.

Finally, we turn to parameter range $L \in (0, \hat{L}(m)]$ for which $\gamma_1(m, L) \leq 0$. From above we know that $\partial\gamma_2(m, L)/\partial m > 0 \ \forall \ L \in (0, \hat{L}(m)]$, which together with $\partial f_C(\gamma; m, L)/\partial m < 0$ and $\partial f_C(\gamma; m, L)/\partial\gamma < 0$ implies that $f_L(\gamma; m, L)|_{\gamma=\gamma_2(m,L)} = f_C(\gamma; m, L)|_{\gamma=\gamma_2(m,L)}$ declines in m. Since $f_C(\gamma; m, L) > f_L(\gamma; m, L) \ \forall \ \gamma \in (0, \gamma_2(m, L))$, we find that parameter combinations of γ and f, which *ex ante* to the increase in m were associated with a multiplicity of equilibria, i.e. $\pi^M(0) > \pi^T(0) \ \wedge \ \pi^M(1) < \pi^T(1) \ \wedge \ \pi^M(1) > \pi^T(0)$, are *ex post* to the increase in m associated with one of three possible equilibria types: a unique equilibrium characterised by no industrialisation, i.e. $\pi^M(0) < \pi^T(0) \ \wedge \ \pi^M(1) < \pi^T(1) \ \wedge \ \pi^M(1) < \pi^T(0)$, a unique equilibrium characterised by incomplete industrialisation, i.e. $\pi^M(0) > \pi^T(0) \ \wedge \ \pi^M(1) < \pi^T(1) \ \wedge \ \pi^M(1) < \pi^T(0)$, or (as before) by a multiplicity of equilibria with $\pi^M(0) > \pi^T(0) \ \wedge \ \pi^M(1) < \pi^T(1) \ \wedge \ \pi^M(1) > \pi^T(0)$. ■

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