

Environmental Regulation And International Competitiveness: A Critical Review

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ENVIRONMENTAL REGULATION AND INTERNATIONAL COMPETITIVENESS: A CRITICAL REVIEW

Abstract

In this paper we critically review the literature on environmental regulation and competitiveness at a national level. The concept of international competitiveness (in relation to environmental regulation) is assessed in two broad schools of thought: neoclassical economics and the competitiveness school to which the Porter Hypothesis belongs. We identify the Pollution Haven Hypothesis (PHH) as the least common denominator for empirical evaluation of the main themes of these two competing schools of thought. As a minimum, one would need to find evidence on PHH to question the validity of the Porter Hypothesis. A fully legitimate test of the Porter Hypothesis should, *inter alia*, have a particular emphasis on the impact of *well*-designed environmental policies on *high-value sectors* of an economy. Examining the recent empirical literature on the PHH we find that the evidence remains inconclusive. This leaves the Porter Hypothesis largely unscathed and challenges the widely-held view of the existence of a trade-off between economic performance and environmental quality.

Key words: competitiveness, environmental regulation, Porter Hypothesis

1. Introduction

Environmental policymaking is often riddled with concerns over international competitiveness. For example, the growing discussion on the theoretical and practical merit of a ‘border carbon tax’ is a direct result of the assumption that jurisdictions with higher carbon prices will be at a competitive disadvantage (Subramanian and Mattoo 2013). Also, in several European countries that have implemented a carbon tax, industry lobby has succeeded in securing exemptions or rebates for trade- and energy-intensive firms to avoid the ‘risk of job losses and carbon-leakage’ (Martin, *et al.*, 2012). A related broader issue here is that if environmental regulations indeed impair competitiveness, there might be some ground for bringing domestic environmental regulations into the domain of trade agreements to prevent a possible ‘race to the bottom’ in environmental standards (Copeland and Taylor, 2004).

What is the precise relationship between environmental regulation and international competitiveness? The burgeoning empirical literature is yet to reach a consensus about this question (see, e.g., Jaffe *et al.*, 1995; Porter and van der Linde, 1995; Ekins and Pecks, 1999; Copeland and Taylor, 2004; Fullerton, 2006). It can be argued that one of the problems in the endeavour for unequivocal evidence is the controversial nature of the concept of competitiveness at the national level and the difficulty of its measurement. Despite wide use in academia and policy circles, the concept of competitiveness is often considered problematic and ill-defined (Krugman, 1996; Neary, 2006, Porter *et al.* 2016).

In this paper we complement the classic reviews of Jaffe *et al.* (1995) and Copeland and Taylor (2004) by critically assessing the concept of international competitiveness (in relation to environmental regulation) in two broad schools of thought: neoclassical economics and the competitiveness school, and by focussing specifically on the *national* (macro) level use of the concept of international competitiveness.¹ By ‘critical’ we mean we start with an interpretive survey of the contentious term ‘international competitiveness’ – rather than taking it as if it were a straightforward concept. This will lead us to relating the Porter Hypothesis to its underlying paradigms of what we refer to as the ‘competitiveness school’ and the related infant industry argument. One consequence of this is the emphasis on a central idea in Porter Hypothesis: ‘high and low value’ products or activities.

The contribution of this paper is twofold. First, by probing into the underlying theories of the two broad classes of thought on competitiveness, we will clarify some of the muddled interpretations of the various hypotheses concerning the relationship between environmental policy and competitiveness and the subsequent empirical testing. For example, we will argue

that trying to test the Porter Hypothesis based on the performance of what Michael Porter might call ‘dog’ industries (not knowledge-intensive) would be barking up the wrong tree. Second, we present an exhaustive review and synthesis of the recent macro literature on environmental regulation and international competitiveness. More importantly, our survey presents an explicit comparison of the Porter Hypothesis with the neoclassical view on the relationship under discussion. We find that the evidence remains as inconclusive as ever – despite claims that accounting for the endogeneity of environmental policy and unobserved country or industry heterogeneity has achieved consensus in the literature.

The remainder of this paper is organized as follows. Sections 2 and 3 discuss, respectively, the neoclassical economics and the competitiveness school views on the issue under discussion. Section 4 presents evaluation of the empirical evidence. Section 5 summarises and concludes the paper.

2. Neoclassical economics on environmental regulation and competitiveness

There is no commonly-accepted definition (and measure) of ‘national competitiveness’ among neoclassical economists; and they do not generally appear comfortable with the term perhaps because it suggests a zero-sum game conception of free trade, which is supposed to be governed by the principle of comparative advantage (Boltho, 1996; Fagerberg, 1996; Neary, 2003; Neary, 2006).² Nonetheless, there is evidently some acceptance, in neoclassical economics, of a legitimate policy concern for ‘competitiveness’, as broadly related to a country’s trade performance, the value of its currency and its average income. This is reflected by one common use of the concept in neoclassical economics which is a cost-based account of competitiveness in the context of macroeconomic performance and its determinants (see, e.g., Boltho, 1996; Neary, 2006).³ Here a lack of ‘competitiveness’ is a problem of real exchange rate (defined as relative unit cost or/and price in a common currency) causing a persistent and undesirable current account deficit while the economy is at full-employment production levels (Boltho, 1996, pp. 2-3). Relative unit cost/price changes when, relative to other countries, the country’s unit cost/price or productivity change or the exchange rate changes. Thus it is assumed that the burden of adjustment to the current account deficit falls on a mixture of deflation and depreciation.

In the context of the impact of environmental regulation/competitiveness linkages, the neoclassical view would assert that stringent environmental regulation in the form of environmental taxes or tradable permits or technological standards will increase production

costs to firms – because compliance in the form of, say, pollution abatement requires real resources – and puts them at a competitive disadvantage against their foreign competitors.

Objections to this conclusion come in different ways which will be addressed in some detail in Section 3. Some words are nonetheless in order here. One major line of argument is that competitiveness is not a matter of cost alone but is also about new and improved products and processes that result from regulation induced environmental R&D and innovations (see Iraldo et al., 2011 for a summary). Another line of argument is that enhancement of competitiveness might also involve ‘corporate reputation’ or ‘green credentials’ in which case cost consideration alone is a poor guide to competitiveness (see e.g. Poelhekke and van der Ploeg 2015).

Neoclassical economists’ response to the first line of argument is based on the assumption that firms are profit maximizers that would not ignore profitable endeavours. They argue that while from time to time, typically as an accident, regulations might lead firms to exploit hitherto unrealised opportunities; it would be generally implausible to assume regulation-driven innovations that enhance competitiveness (Palmer et al., 1995). With respect to the second line of argument, neoclassical economists do not seem to have anything to say – to the best of our knowledge. While ‘corporate image’ as goodwill can generally represent an intangible asset for companies, in the world of neoclassical economics ‘corporate reputation’ does not seem to have a significant value.

So the bottom line for neoclassical economists is that regulations causes the location of production (especially that of pollution-intensive industries) to shift away from the domestic economy to countries with relatively lax environmental regulation (Copeland and Taylor, 2004). In effect, the country’s international ‘competitiveness’ – in the sense of export performance and locational attractiveness – will be impaired. Trade deficit would be a likely outcome.

Restoration of the trade balance in the ‘long-run’ is expected to reduce welfare because it will entail depreciation and/or real wage reductions. It is conceivable that the economy will restructure to engage in new sectors in which it can be more competitive. But restructuring or adjustments involve costs. Especially when the loss of competitiveness occurs in important sectors (in terms of employment and output), the transition to a new equilibrium can be painful (see, e.g., Jaffe *et al.*, 1995; Ekins and Pecks, 1999).

The above argument of focussing on adjustment costs is on the assumption that environmental regulation is set efficiently the world over, i.e. on the basis of cost-benefit considerations. There is no reason to believe this assumption is true. Especially in trans-

boundary pollution problems (such as carbon dioxide emissions) where location of emissions is irrelevant, climate policy might be ineffective (and hence might not be set efficiently) due to relocation of ‘dirty’ industries. More generally, governments deprived of trade policy instruments may have an incentive to manipulate environmental policy as an instrument of trade and investment policy. One possible explanation for this is interest group politics where governments succumb to rent seeking groups and weaken environmental regulations. The main point here is that the possibility for such strategic uses of environmental policy might justify calls for bringing domestic environmental regulations into the domain of trade agreements to prevent a ‘race to the bottom’ in environmental standards (Copeland and Taylor, 2004).

To summarise, the main conclusion of neoclassical economics is that regulated firms see their costs rising, putting them at a competitive disadvantage vis-à-vis their foreign competitors. This will in turn negatively impact the location of production and subsequent export performance of the national economy.⁴ This is the essence of the Pollution Haven Effect (PHE).⁵

3. The competitiveness school on environmental regulation and competitiveness

3.1. The concept of competitiveness in the competitiveness school

An alternative to the neoclassical economics’ view on competitiveness is what we can call the competitiveness school. This school sees beyond ‘ability to sell’ and ‘locational attractiveness’, and generally adopts the view that international competitiveness is about wealth creation in the context of international division of labour (Reinert, 1995, 2009). This can be seen from the specific definitions given by various authors along the line of “competitiveness is our ability to produce goods and services that meet the test of international competition while our citizens enjoy a standards of living that is both rising and sustainable” Tyson (1992, p. 1). Similarly, Porter and Rivkin (2012a, p. 56) argue: “The U.S. is a competitive location to the extent that companies operating in the U.S. are able to compete successfully in the global economy while supporting high and rising living standards for the average American”.

According to this school, competitiveness is thus primarily about engagement and efficiency in ‘high-value’ sectors that raise the overall performance of a national economy. “Being the most efficient in the ‘wrong’ activities, the opposite of competitiveness, leads to negative development” (Reinert, 1995, p. 26). The ‘right’ activities are those characterized

by scale economies and imperfect competition and generally coincide with high-technology industries where their success creates national benefits in productivity and high-wage; hence such industries are the backbone of national competitiveness (Porter, 1990, p. 282; Tyson, 1992, p. 18; see also Porter et al., 2016).⁶ The underlying key attribute of such ‘desirable’ activities is their capacity to foster innovation leading to increased productivity broadly defined – both process and product quality improvements (Fagerberg *et al.*, 2006).

The crucial element of this competitiveness view is that different activities play divergent roles in the overall domestic economic success: namely, high-technology industries are more ‘valuable’ (Reinert, 1995, p. 33). That sounds trivial but not so, if you agree with the new trade theory (including its subfield: strategic trade theory) which demonstrates that it is possible to create comparative advantage in such valuable activities. The comparative advantage a country may have in these ‘desirable’ industries does not have much to do with factor endowments (Porter, 1990, p. 74). But what exactly forms the basis of trade that replaces (given) factor endowments, and how exactly does a ‘created’ trade pattern relate to domestic welfare?

3.2. *The basis of trade in ‘advanced products’*

In what follows, we attempt to provide an intuitive answer to the questions we just posed. The answer provides the general framework underlying the original Porter Hypothesis which has a clear link to the ‘new trade theory’.⁷ The basis of trade in new trade theory is product differentiation and increasing returns to scale that permits trade between countries endowed with similar relative factor endowments.⁸ That is because specialization, together with larger scale of production, allows a country to reduce a product’s production costs relative to its trading partner (Helpman and Krugman, 1985).

Increasing returns to scale is generally incompatible with perfectly competitive markets. With scale economies, marginal cost pricing results in a loss, so such technologies entail imperfect competition to allow above marginal cost pricing. Now, in the presence of increasing returns, a country that happens to have a larger share of the market at an early stage can eventually dominate the market because as scale increases costs fall and quality improves. Moreover, the existence of imperfect competition prevents productivity growth from fully translating into lower prices – an affront to the factor price equalization theorem of neoclassical trade theory. This means that a large proportion of the benefits of improved

productivity is retained in the form of higher wages, higher profits and higher income taxes in the producing nation (Reinert, 1995, p. 27).

A country's larger share at an early stage can arise from an early 'minor' advantage (*c.f.* Porter's 'first mover advantage') – i.e. there is 'path dependence' (see note 6). This implies that a country can, in principle, use subsidies or tariffs to nurture selected industries that are potentially characterized by dynamic external economies. Conversely, a country that is less efficient than its trading partner in these industries will find it difficult to turn the balance of comparative advantage in its favour (*c.f.* where the Porter Hypothesis belittles the role of environmental compliance costs in international competitiveness – more on this below).

The foregoing story underlies the traditional infant industry argument which justifies temporary protection (via trade barriers) of fledgling domestic industries from established and more efficient international competitors. In the short-run such protection would result in a national welfare loss caused by its substitution of low-cost imports by higher-cost, domestic production. In the long-run, however, the infant industry would mature and increase its productivity (owing mainly to innovations) that could outweigh the short-term static inefficiencies arising from a higher-cost domestic production. A key assumption in this process is the existence of external economies of scale operating within national boundaries. In other words, productivity-enhancing innovations have a collective impact on the industry and this impact depends on the size of the industry.⁹ There is sufficient historical and more recent evidence on successful industrial policies (see Vietor, 2007 for detailed historical experience of industrial policy). For example in Japan the famous Ministry of International Trade and Industry in the 1950s-60s fostered 'industry restructuring' by selecting strategic industries for special support. Similarly, South Korea's miraculous growth was a result of targeted industrial policy in the 1960s. In China the industrial policy adopted in the ninth five-year plan (1996-2000) targeted "five pillar industries for special protection": machinery, electronics, petrochemicals, construction and electronics (p. 68). The 2008 Growth Commission Report of the World Bank states that "governments in the high-growth economies tried a variety of policies to help diversify exports or sustain competitiveness. These included industrial policies to promote investment in new sectors..." (p. 23).

It should be noted that the above discussed government role on the basis of infant industry argument is not a substitute for but is in addition to one basic role for government generally accepted in the competitiveness debate (see Mulatu, 2016 for a detailed discussion). And that is a broad (i.e. not industry-specific) role for government to ensure enabling or supporting

national and business environments under which firms in general operate (Porter *et al.*, 2008). Such environments should provide modern physical infrastructure, good healthcare and basic education, effective political institutions (such as rule of law), effective capital markets, efficient regulations (relating to business) and quality institutions for higher education and science. This has some parallel with the ‘factor condition’ corner of Porter’s (1990) classic diamond model.

In summary the competitiveness school espouses the idea of competitiveness as a “winner-picking exercise” by social planners for special protection or promotion (Arthur 1990, p. 84; Reinert, 1995, p. 41).

3.3. *The competitiveness school and environmental regulation*

On the question of environmental regulation/competitiveness linkages, the competitiveness school, particularly Michael Porter represents a view that is in stark contrast to the view of neoclassical economics. He argues: “Strict environmental regulations do not inevitably hinder competitive advantage against foreign rivals” (Porter, 1991, p. 96). Indeed the argument goes: well-designed environmental regulation can enhance growth and competitiveness by fostering innovation which results in returns that can partially, or more than fully, offset the costs of compliance (Porter and van der Linde, 1995, p. 98; see also Porter, 1990). It is this view that goes by the name of the “Porter Hypothesis”.

One of the underlying reasons of these divergent views arguably lies in the source of comparative or ‘competitive advantage’ in the two paradigms. According to Porter and van der Linde resource endowment plays no significant role in the competitive advantage of firms, especially of those firms that are the ‘backbone’ of advanced economies. Hence, environmental regulation that is hypothesized to limit firms’ access to the ‘services of the environment’ does not have much to do with firms’ relative performance. They assert that: “Internationally competitive companies are not those with the cheapest inputs or the largest scale, but those with the capacity to improve and innovate continually” (Porter and van der Linde 1995, p. 98).

Porter and van der Linde (1995, p. 100) identify five major reasons why well-designed environmental regulations can lead to a win-win outcome: 1) regulation serves as a signal to firms about resource inefficiencies and possibilities for technological improvements; 2) regulation that merely requires firms to gather information (such as release of toxic chemicals) raises corporate awareness and thereby achieves environmental improvements; 3)

regulation reduces uncertainty about the value of environmental investments; 4) regulation provides pressure that incentivizes innovation; 5) regulation “levels the transitional playing field” ensuring all firms make the required environmental investment.

Interestingly, Porter Hypothesis’ story of regulation-induced innovation offsets gets some support from *formal* neoclassical economic models that demonstrate environmental policy resulting in welfare increases – excluding the benefit of a cleaner environment – (see, for e.g., Mohr, 2002; Greaker, 2003; Mohr and Saha, 2008; and Andréa *et al.*, 2009).¹⁰ The key idea in these models is a strategic role in technology adoption that is motivated by the twin key assumptions of technological change and external economies of scale in production (analogous to what Porter might call spillovers between firms in localized clusters). As pointed out by Mohr (2002), the analogy between his Porter-Hypothesis-type result and the infant industry argument of a strategic trade policy is evident. In both cases the basic theme is *nurturing* potential ‘winners’ – industries that are characterized by external economies of scale. However, unlike the method of protection underlying the infant industry argument, environmental regulation does the nurturing by *forcing* firms (thereby solving the ‘coordination failure’ which causes firms’ under-investment in cleaner and more productive technologies) to engage in innovations that can (more than) pay for the costs of compliance to regulation.

One aspect of the Porter Hypothesis needs to be emphasized. While there may not be much explicit in PH about what sector of the economy it applies to, we argue that the PH must have a particular focus. As noted above, for the competitiveness school, a concern for competitiveness focuses on ‘winner’ industries: “If the industries that are losing position to foreign rivals are the more productive ones in the economy, a nation’s ability to sustain productivity growth [read competitiveness] is threatened” (Porter, 1990, p. 9). Indeed according to Porter, one of the mechanisms for raising competitiveness is farming out the ‘dog’ industries (i.e. low-productivity activities) to others and importing the products concerned. The following statement is particularly revealing: “...America can be better off when a low-value-added manufacturing task is moved from the Midwest to Brazil...” (Porter and Rivkin, 2012b, p. 60).

That means the Porter Hypothesis of regulation-induced innovation offsets and enhancement of competitiveness refers specifically to ‘winner’ industries, i.e. technology-intensive sectors. As already pointed out above, in such sectors price or cost *per se* (such as environmental compliance cost) is not crucial for international competitiveness. When Porter

and van der Linde state “...the sectors where high environmental costs were associated with negative trade performance were ones such as ferrous metal mining, non-ferrous metal mining,...where the U.S. suffers from dwindling raw material deposits, very high relative electricity cost,...that have rendered them uncompetitive quite apart from environmental costs” (1995, p. 108) they are suggesting that the focus has to be on ‘winners’ and that ‘laggards should be ignored’.

In summary, Porter’s view is that international competitiveness is about hosting selective technology-based industries that are capable of raising standards of living in the entire economy. Such industries are not the sorts that are easily flustered by environmental regulation. Indeed, their very nature means that they can actually benefit (i.e. enhance their competitiveness) from well-crafted environmental regulation.

4. An overview of the empirical evidence

The two competing hypotheses discussed in Sections 2 and 3 are summarised in Figure 1. Empirical evaluation of competing hypotheses can be difficult for one reason or another. An empirical work claiming to test a certain hypothesis may not be accurately doing so, perhaps because of the difficulty of operationalizing the concepts or unavailability of appropriate data. As shown in Figure 1, here the problem is compounded because the two schools that we want to evaluate do not just have different predictions of the impact of environmental regulation on competitiveness – but also have somewhat different perspectives of international competitiveness itself. Moreover, as already pointed out the competitiveness school’s (the Porter Hypothesis’) claim of a win-win outcome of environmental regulation is highly conditional on the regulation being ‘well-crafted’. Indeed the issue of the ‘right’ kind of environmental regulation (in a particular situation) in terms of efficiency, effectiveness and impact on competitiveness is highly debated in the literature (see Iraldo et al., 2011 for a critical summary). While command and control mechanisms (direct regulation) can in certain circumstances be viewed as effective, economic instruments such as taxes and tradable permits are generally credited for superior efficiency compared with direct regulation. Therefore, Porter’s ‘well crafted’ regulation is usually understood to mean ‘flexible market based regulation’ (Ambec et al., 2013).

< Figure 1 about here >

Coming back to our concern of empirical evaluation of the two competing hypotheses identified, a sensible approach is then to focus on what might be the least common

denominator of the possible hypotheses of the two schools. The neoclassical view is represented by the PHE. Environmental regulations cause the domestic industry to suffer a cost disadvantage against foreign rivals and consequently impair export performance and locational attractiveness (especially those of pollution-intensive sectors). As argued above, whether the ultimate effects (of these changes in trade and investment flows) represent ‘adjustment costs’ and ‘real exchange rate problem’ or ‘competitiveness’ is largely a matter of semantics.

On the side of the competitiveness school, Porter Hypothesis’ story of regulation-induced ‘innovation offsets’ has several versions or interpretations (see, e.g., Jaffe *et al.*, 1995; Ambec *et al.*, 2013). The analysis in the literature includes such varied outcome measures as productivity (efficiency scores and TFP), innovation (environmental patents and environmental R&D expenditure), age of capital stock, etc. for particular industries or the manufacturing sector as a whole or national economies (see Kozluk and Zipperer, 2014 for a recent critical review). The conclusion of this review is that the empirical results are generally inconclusive. There is also a somewhat unique and interesting study on economy-wide reallocative costs of the U.S. Clean Air Act by Walker (2013). The study reports that the total earnings loss to workers in regulated plants amounted to \$5.4 billion.

One approach used in the literature to test the hypothesis on which we will focus is a major stand of national measures of competitiveness, namely trade and foreign investment flows. This set of measures is more explicitly related to our particular focus of international competitiveness. Indeed, this set of measures broadly represents the original hypothesis of Porter that environmental regulation can enhance a country’s competitiveness (Porter, 1990; Mohr, 2002, p. 158; Ambec *et al.*, 2013). However, as emphasized in Section 3, for the competitiveness school national competitiveness relies on ‘high-value’ industries that are capable of raising living standards throughout the economy.

Therefore, the PHE appears to be the common hypothesis for both schools of thought. However, given the qualifications of the Porter Hypothesis (i.e. regulation has to be well-crafted and competitiveness has to do with selective industries) evidence on PHE alone is not sufficient to reject the Porter Hypothesis. It is only the minimum evidence required to question Porter Hypothesis’ validity. A fully legitimate test of the Porter Hypothesis should, *inter alia*, have a particular emphasis on the impact of *well-designed* environmental policies on *high-value* economic sectors. More on this in Sub-section 4.3; now we turn to evaluate the least common denominator: the PHE. Before proceeding we should reiterate here that we are

by no means suggesting that the PH is all about international competitiveness and the PHH. As we have already pointed out, the central notion of PH that ‘environmental regulation can lead to profit enhancing innovations’ has had several interpretations and been tested empirically in different ways (see Ambec et al., 2013 for a review). Our focus is on one interpretation of the PH, arguably its original form, which suggests that environmental regulation can enhance national competitiveness and hence would not lead to the emergence of pollution havens.

4.1. *The impact of environmental regulation on trade flows*

The empirical literature on environmental regulation and trade flows has a history going back to the early 1970s. As the earlier literature has been sufficiently reviewed, we focus here on the recent econometric literature (roughly from year 2000 to date).¹¹ The main empirical tools are those motivated by the Heckscher-Ohlin theory, specifically the Heckscher-Ohlin-Vanek (HOV) equation, which broadly states that a country exports (imports) the commodity that entails relatively more (less) intensive use of the factor that is relatively more (less) abundant in that country. There are two versions of the HOV motivated empirical tool of trade (Leamer, 1984). The first is a cross-country regression of net exports of a given commodity group on factor endowments, of which one is environmental regulation:

$$T_{it} = \alpha_i + \eta_t + Z_{it}\gamma + \beta R_{it} + \mu_{it}, \quad (1)$$

where T is a vector of net-exports of a commodity in country i at time t , α and η are, respectively, time-invariant location and location-invariant time fixed effects, Z is a matrix of control variables, namely national factor endowments (i.e. abundance of production factors such as labour and capital), γ is a vector of coefficients, and μ is a vector of error terms. The variable R represents some measure of national level environmental stringency. (Because it is a cross country regression for a single commodity (group), the explanatory variables are country-level variables). There has been very limited application of this version of the HOV model mainly because of lack of comparable stringency measure across countries. To the best of our knowledge there are only three studies, Cole and Elliot (2003), Diakosavvas (1994), Tobey (1990), which report mixed and weak evidence.

The second version is the cross-commodity equation that aims to explain the trade pattern of a particular country by factor intensities. In effect, it tries to reveal factor abundance from

a regression of trade on factor intensities. Net exports or imports of a commodity are assumed to be a linear function of factor-intensities in the production of that commodity as follows:

$$T_{it} = \omega_i + \pi_t + A'\theta + \phi S_{it} + \varepsilon_{it}, \quad (2)$$

where T is a vector of a country's net exports or imports of commodity i at time t . ω and π are vectors of, respectively, time-invariant industry and industry-invariant time fixed effects, A' is a matrix of factor intensities (i.e. the required level of factor input (such as labour) use by industry) , which typically include (skilled) labour intensity, capital intensity, R&D intensity, and other controls such as tariff, θ is a vector of coefficients to be estimated, and ε is a vector of error terms. S represents pollution-abatement-and-control costs incurred by (or emission intensities of) industries to capture R in equation (1) as it applies to a particular industry. (Because it is a cross-commodity regression for a single country, the explanatory variables refer to commodity groups). This is by far the most typical model employed in the empirical literature.¹² The early set of studies in this category has been critically reviewed by, among others, Jaffe *et al.* (1995) and Copeland and Taylor (2004). For brevity and completeness we only summarise the conclusion made in these reviews and proceed to a brief review of studies from about 2000 onwards – those that have not been sufficiently covered by Copeland and Taylor (2004). An overview of these studies is given in Table 1.

< Figure 1 about here >

The main feature of these early studies is the use of cross-sectional data (mainly of U.S. industries) and treatment of environmental regulation as exogenous. The widely quoted conclusion from Jaffe *et al.* (1995, p. 157) goes: “Overall, there is relatively little evidence to support the hypothesis that environmental regulation has a large adverse effect on competitiveness, however that elusive term is defined”. A different conclusion is given by Copeland and Taylor (2004, p. 41) who argue that “[i]n sharp contrast to the earlier work, these studies have tended to find that differences in environmental policy do affect trade and investment flows”.

Some more recent studies also suggest a detrimental impact of environmental stringency on trade flows. The distinguishing feature of these studies is that they account for endogeneity of environmental regulation i.e. for the possibility that such a regulation responds to the size and structure of trade and investment flows. Countries with large

production by polluting industries might raise their environmental standards or those with negligible amount of polluting activities may not enact stringent environmental policies (Millimet and Roy, 2015). The exceptions are Cole and Elliott (2003) who use cross-sectional data, and Mulatu *et al.* (2004) and Babool and Reed (2010) who both treat environmental policy as exogenous.

Cole and Elliott (2003) distinguish between two somewhat different questions and examine respectively in the Heckscher-Ohlin and in the new trade models: does environmental regulation affect net exports of pollution-intensive goods?; and does environmental regulation, like the traditional factor endowments, play a role in the composition of trade? The answer to the second question is consistent with the PHE while to the first question it is not. Ederington and Minier (2003) directly test PHE on the basis of a simultaneous determination of U.S. manufacturing imports and pollution abatement costs. Unlike the results of the standard panel estimators, the instrumental-variable estimator reveals the pollution haven effect. In a change of focus, Ederington *et al.* (2004) examine the changing patterns of specialization in U.S. manufacturing exports and imports in the face of trade liberalization. They find no evidence of a disproportionate rise in dirty-good imports – hence no evidence of the pollution haven effect.

Mulatu *et al.* (2004) investigate manufacturing net exports data from Germany, the Netherlands and the U.S. and report mixed results – varying across estimators, countries and industry groups. Cole *et al.* (2005) analyze the U.S.'s revealed comparative advantage to examine the hypothesis of a decline in the U.S.'s specialization in pollution-intensive industries. They find no support for a pollution haven effect and conclude that such industries are also intensive in physical and human capital with which the U.S. is relatively well endowed. Ederington *et al.* (2005) examine U.S. net imports and make a crucial observation that pollution intensive industries tend to be less geographical mobile. Taking due account of these observation and also the source of imports (developing versus developed countries), they find a significant pollution haven effect. Cole *et al.* (2010) undertake a similar study for Japan and arrive at the more or less identical conclusion. Levinson and Taylor (2008) analyse net exports of U.S. industries. Using panel estimators and instrumenting for the environmental variable they find evidence of the pollution haven effect. Babool and Reed (2010) examine net exports from OECD countries using panel data while treating pollution control costs as exogenous. The results are mixed. For paper and wood which are pollution-intensive and textile products which are not, they find a positive relationship between net exports and environmental regulation; for most other manufacturing industries they find the

reverse. The authors try to explain their finding of ‘unexpected’ positive relationship with respect to paper and wood by invoking the Porter Hypothesis and arguing: this sector “uses a renewable resource that can be managed and advertised as such on products [which] could make net exports more responsive to documented environmental regulations” (p. 2322).

4.2. *The impact of environmental regulation on foreign investment flows*

A second strand of the literature in the PHE is focused on Foreign Direct Investment (FDI).¹³ Again we ignore the early studies already critically reviewed in, among others, Jaffe *et al.* (1995). An overview of these studies is provided in Table 1. The empirical tools for analyzing FDI patterns generally use the same explanatory factors employed in the empirical trade literature discussed above (Eskeland and Harrison, 2003, p. 6). A generic model of FDI flows can be written as:

$$FDI_{ijt} = \alpha_i + \lambda_j + \eta_t + K_{it}\tau + V_{jt}\delta + \psi R_{it} + e_{ijt} \quad (3)$$

where FDI_{ijt} is a vector of a measure of a multinational enterprise’s activity (including a binary variable of 0 or 1 for the existence of a multinational enterprise) in location i , industry j and year t . K and V are, respectively, matrices of observable control variables, namely: location characteristics and industry attributes. The variable R represents stringency of national environmental regulation. α , λ and η are vectors of, respectively, time-invariant location and industry fixed effects, and location- and industry-invariant time fixed effects. τ and δ are vectors of coefficients, and e is a vector of error terms. To the best of our knowledge, the only study that has estimated this most general specification is Poelhekke and van der Ploeg (2015). Kellenberg (2009) which uses a ‘region’ dummy instead of ‘country’ dummy for location fixed effects is closer to this general formulation. Either index i or j will not appear in all other papers. The reason for this is unavailability of such a rich three-dimensional dataset; or when it is available as in the case of Kellenberg, for example, the limited year to year variation in most country characteristics variables (especially the environmental variable) makes estimation impossible due to multicollinearity.

Location in Equation (3) refers to country, state or region, and the characteristics can include three broad classes of variables. The first is gravity-model type variables such as GDP, GDP per capita, distance and a common language (as in Javorcik and Wei, 2004;

Kellenberg, 2009; and Manderson and Kneller, 2012) whereas Kheder and Zugravu (2012) use market potential.

The second is Heckscher-Ohlin type variables that include infrastructure quality and traditional factor endowment variables such as labour, capital, land and energy (as in Dean *et al.*, 2009; Kellenberg, 2009; Millimet and Roy, 2015; and Manderson and Kneller, 2012).

The third is general policy environment which typically includes corruption, protection of intellectual property and openness to trade (as in Javorcik and Wei, 2004; Kellenberg, 2009; and Manderson and Kneller, 2012).

Typical industry attributes that appear in Equation (3) are largely the counterpart of the country characteristics and include: factor intensities (such as skilled labour and R&D use) and factor prices including pollution control costs (or emissions); intangible assets (one common proxy of which is labour productivity); exports share and scale economies (as in Eskeland and Harrison, 2003; Javorcik and Wei, 2004; Manderson and Kneller, 2012; and Kheder and Zugravu, 2012).

About half of the studies that are based on Equation (3) are focused on investigating inbound FDI. List and Co (2000), Keller and Levinson (2002), Fredriksson *et al.* (2003) and Millimet and Ray (2015) all find some evidence of a pollution haven effect, namely that stringent environmental regulation lowers FDI inflows to the U.S. The latter three studies treat environmental regulation as endogenous. Studies that focus on inbound FDI to countries other than the U.S. include Javorcik and Wei (2004) who examine inbound FDI to eastern Europe and the former Soviet Union; Dean *et al.* (2009) that focus on inbound FDI to China; Waldkirch and Gopinath (2008) who consider the case of inbound FDI to Mexico; and Cole and Fredriksson (2009) who analyse patterns of FDI inflows to 13 OECD and 20 developing countries. The results in each of these studies are rather heterogeneous along various dimensions: measures of environmental stringency (Javorcik and Wei, 2004); measures of pollution and groups of industries (Waldkirch and Gopinath, 2008); and pollution intensity and country of FDI origin (Dean *et al.*, 2009). Only Cole and Fredriksson (2009) treat environmental regulation as endogenous and report evidence of a pollution haven effect.

Studies on outbound FDI also mainly focus on the U.S. Xing and Kolstad (2002) compare regression results for dirty and clean industries (or all manufacturing) and obtain some evidence of a pollution haven effect for heavily polluting U.S. industries. Eskeland and Harrison (2003) also examine the pattern of U.S. FDI to developing countries to see if the latter are used as pollution havens. They find no robust evidence for the emergence of

pollution havens – a result they ascribe to the potential complementarity between capital (which the U.S. is well endowed with) and pollution abatement. Cole and Elliott (2005) investigate the pattern of U.S. FDI flows to Brazil and Mexico – countries that are not too capital-poor and hence, the authors argue, are likely pollution havens because of a strong correlation between capital-intensity and pollution-intensity. Treating environmental policy as endogenous, they find that the ‘key forces’ of attraction for a U.S. industry is its capital requirements while pollution control costs in the U.S. is also a push factor. Kellenberg (2009) analyses the value added of U.S. outbound FDI in a cross-country and cross-industry setting, treating environmental regulation as endogenous. He reports a robust pollution haven effect. Hanna (2010) examines U.S. outbound FDI but she uses a difference-in-difference model – with no observable firm/industry controls – and finds evidence of a pollution haven effect.

There are nine non-U.S. studies on outbound FDI. Ljungwall and Linde-Rahr (2005) study FDI flows to 28 Chinese provinces between 1987 and 1998. Using provincial pollution levy paid by the average firm, they report that environmental policy reduce FDI in only less developed regions of China. Similarly, Di (2007) uses data on a cross-section of Chinese provinces for 1996 and concludes that FDI firms in polluting industries are deterred by environmental regulation. Spatareanu (2007) examines FDI flows in Europe and considers differential stringency of environmental regulation between home and host countries. She reports that stringency is associated with both higher probability of FDI occurrence and larger volume of investment. Kheder and Zugravu (2012) analyse the patterns of French outbound FDI while Kirkpatrick and Shimamoto (2011) examine Japanese FDI in pollution-intensive firms alone. Finally, Manderson and Kneller (2012) and Poelhekke and van der Ploeg (2015) do the same respectively for the Netherlands and for U.K outbound FDI.. Kheder and Zugravu (2012) report somewhat mixed evidence: a pollution haven effect for their pooled sample and for some subsets of the sample but not for developing countries that have ‘too lax’ environmental regulation. Kirkpatrick and Shimamoto (2011) and Manderson and Kneller (2012) fail to find robust evidence to suggest that environmental regulation is a strong influence on the location behaviour of multinationals firms. On the contrary, Kirkpatrick and Shimamoto (2011) find that Japanese FDI seems attracted by stringent but ‘stable environmental regulatory framework’.

Poelhekke and van der Ploeg (2015) report a somewhat unique evidence of both pollution haven effects and green haven effects (where CRS minded footloose sectors are attracted by higher environmental standards). Poelhekke and van der Ploeg’s (2015) finding needs some

emphasizing. The key message is that there is no ‘average’ effect of regulation on FDI outflow; the effect depends, among other things, on the home country (green credentials matter) and the nature of the sector.

4.3. *Summary remarks on the empirical evidence for the PHE*

Overall, the weight of the evidence from both strands of the literature suggests that compared to the earlier work, increasingly studies document findings of a pollution haven effect. Nonetheless, there are numerous studies that fail to find any evidence on the PHE. And this failure does not have much to do with the use of sophisticated econometrics. So unlike what Copeland and Taylor (2004) seem to suggest, accounting for endogeneity of environmental policy and unobserved location and industry heterogeneity has not quite solved the puzzle of finding the pollution haven effect.

Does it follow from this that we have some evidence of the Porter Hypothesis? No, what we can say is that there is no conclusive evidence refuting the Porter Hypothesis. Indeed, we can argue that even if we were willing to be persuaded by the argument that most recent studies have succeeded in uncovering the pollution haven effect, it would still be wrong to take this as clear evidence rejecting the Porter Hypothesis. First as already pointed out above the Porter Hypothesis hinges on well-designed environmental regulations to spur innovation that offsets environmental compliance costs. There is no reason to believe that the various measures of regulatory stringency employed in the literature are what Porter would call ‘well crafted’ (Ambec *et al.* (2013) also makes this point). According to Porter and van der Linde (1995, pp. 110-111) the key to a win-win outcome of environmental regulation is that the regulatory system has to focus on “clear goals [and] flexible approaches”. Lack of clarity and the associated uncertainty undermines a long-term and continuous effort to innovate. Rigid technological standards deprive firms of endeavouring for innovative approaches to achieving the desired goal of emissions reduction. Economic incentive approaches (such as emissions charges and emissions trading) leave the issue of how to achieve assigned environmental goals to firms and thus make the burden of compliance easier or even lead to innovation offsets.¹⁴ There is some micro level evidence on such win-win outcomes of market-based environmental regulations (see Lankoski (2010) for a recent review).

There is a second reason why evidence on the PHH should not be taken as clear evidence to refute the Porter Hypothesis. As already discussed in Section 3, to Porter international competitiveness of a national economy is tied to particular industries, namely those engaged

in technology-intensive industries. Porter admits that environmental regulation might cause what he calls ‘dog’ industries (i.e. not knowledge/technology-intensive ones) to lose out in the international competition for market share. But he does not view this as a concern because such industries do not have much to do with international competitiveness of the national economy. Those industries capable of maintaining or enhancing international competitiveness of the national economy while being micro-economically competitive are likely to thrive rather than be weakened by environmental regulation. The PHE empirical literature is largely oblivious to such sector-specific views of the Porter Hypothesis. That is to say, it does not explicitly test Porter-type hypotheses that go along the lines of ‘internationally competitive firms that are capable of raising standards of living for the nation as a whole are unlikely to be impaired by a well designed environmental regulation’.

It should be pointed out that there is a danger of unduly insulating the Porter Hypothesis against possible falsifications if we downplay any evidence contradicting the hypothesis by saying ‘the focus was not on technology-intensive industries or the regulation was not well-designed’.¹⁵ However, our main argument here is that there is hardly any conclusive evidence of the PHE even for the non-technology-intensive industries and for possibly badly designed regulations.

5. Summary and concluding remarks

This paper is a critical review of the literature on environmental regulation and international competitiveness with a particular focus on the macro-level use of the concept of competitiveness. We identify two broad schools of thought on competitiveness and discuss at length the basic tenets underlying each. Neoclassical economics, while reluctant to use the concept at the national level, sees an adverse effect of environmental regulation on a national economy at least owing to the inevitable costs of restructuring. Such costs can be reflected in national measures of international competitiveness such as trade and foreign investment flows which are indeed the object of investigation in the PHE.

In contrast, the competitiveness school maintains that international competitiveness – in the sense of raising domestic income in the face of international division of labour – is something economies should actively aim to enhance by nurturing ‘winners’ – industries that involve dynamic externalities such as scale economies. Interestingly enough, environmental regulation can be ‘nurturing’ by forcing firms (hence solving the ‘coordination problem’ among themselves) to engage in innovations, the benefit of which can (more than) offset the

compliance costs. Consequently, environmental regulation can go hand in hand with maintaining or improving competitiveness of an economy that is dependent on the success of ‘winner’ industries, which rather than being flustered by regulation are likely to thrive. This favorable outcome could in turn be reflected in rising export shares and investment inflows of industries with superior productivity.

The empirical evidence pertaining to the PHE has yet to reach a consensus view on the precise relationship between environmental regulation and trade and investment flows. True, more and more recent studies with sophisticated econometrics tend to document some evidence of the pollution haven effect, but the literature as a whole is far from presenting robust evidence supporting the PHE. One can therefore argue that the Porter Hypothesis (in the particular interpretation adopted here) remains largely unscathed because, at the least, one would need to find evidence on the PHE to question the validity of the Porter Hypothesis. A fully legitimate test of the Porter Hypothesis should, *inter alia*, have a particular emphasis on the impact of properly designed environmental policies on ‘high value sectors’ of an economy.

With further integration of the world economy through successive trade agreements that gradually phase out trade barriers such as quotas and tariffs, a concern for international competitiveness might lead governments to use environmental policy as a hidden trade policy. In particular, the march to increased globalisation could cause a race-to-the-bottom in environmental regulation as jurisdictions try to undercut each other’s standards. The conclusion of this review paper questions the premise of this whole debate: well designed and consistently enforced environmental regulations do not seem to impair competitiveness significantly.

Notes

¹ We use the term neoclassical economics rather loosely to refer to theories based on the following key assumption: individuals have rational preferences among outcomes; individuals maximize utility and firms maximize profits; and individuals act independently on the basis of full and relevant information (Weintraub, 2013). We also use the term ‘the competitiveness school’ loosely to represent the Porter Hypothesis and the underlying paradigm whose distinction is apparent from the title of Porter’s major work, *The Competitive Advantage of Nations* (1990), which is itself a dissent from the centuries-old principle of ‘comparative advantage’.

² Some consider the concept to be unimportant, irrelevant or misleading (see, e.g. Krugman, 1996). Notice how Jaffe *et al.* (1995) put *competitiveness* in quotation marks and refrained from offering a concrete definition for it.

³ Note the proposed indices of competitiveness by IMF based economists (e.g. Marsh and Tokarick, 1994) and the regular publication of similar indices by *The Financial Times*.

⁴ A related point here is the potential spill over benefits (by way of diffusion of technology including better environmental products and standards) to countries receiving FDI. While such benefits are not inevitable and materialize only on particular conditions (see e.g. Blomstrom and Kokko, 2001 and Kokko *et al.*, 1996) the key point remains that the competitiveness advantage of being an attractive location can potential be considerable.

⁵ PHE should be distinguished from its closely related term, the Pollution Haven Hypothesis which describes the effect of trade liberalization on pollution-intensive industry in countries with lax regulation (Copeland and Taylor, 2004, p. 9).

⁶ There are different types of classifications for high technology industries and the basis of the classification can be judgments by experts (Tyson 1992, p. 20).

⁷As the father of new trade theory, Paul Krugman has *in principle* much to agree with the competitiveness school, but like most fellow neoclassical economists he is a “cautious non-activist” and parts company with this school when it comes to policy prescriptions because of the difficulties involved in practical formulation of strategic trade and industrial policies (Krugman, 1996, pp.110- 111).

⁸ Increasing returns essentially means the advantages of large-scale production. The significance of the concept of increasing returns derives from the issue of how early (seemingly inconsequential) events, which cause an increase in scale, feed on themselves to increase the scale even further in a dynamic setting (in other words the system is path-dependent (Arthur, 1990).

⁹As we will see below Mohr (2002, p. 167) presents an argument along these lines in his story of a win-win outcome of environmental regulation because of induced ‘innovation offsets’.

¹⁰ While these neoclassical models show that the Porter Hypothesis is a theoretical possibility, they emphasize that the potential problem with implementation of an environmental policy leading to a win-win outcome outweighs the potential benefit. And hence the policy implication they draw is still the traditional ‘benefit-cost-rule’ to environmental policy making (see Mohr 2002, p. 167).

¹¹Jaffe *et al.* (1995) and Copeland and Taylor (2004) present two prominent reviews. The earliest studies were of exploratory nature investigating trends in trade, especially in dirty goods (see Mulatu *et al.*, 2003). The results reported by these studies are mixed but suffer from a serious weakness. “The search for pollution havens in the data has obscured the role capital accumulation and natural resources must play in determining dirty-industry migration” (Copeland and Taylor, 2004, p. 41).

¹²There are two sets of exceptions. Notable examples in the first include van de Beers and van den Bergh (1997, 2003), Kee *et al.* (2010) and Arouri *et al.* (2012) who employ a gravity model. Somewhat similar to this group of studies, Grether *et al.* (2012) also use a gravity framework but focus on analysis of the ‘pollution content of trade’. While van de Beers and van den Bergh (1997, 2003) find mixed evidence for the pollution haven effect; Grether (2015) also find a pollution haven effect albeit ‘not quantitatively significant or systematic’; and the other two do not find any evidence supporting the PHE. The second set consists of Kahn (2003), Cave and

Blomquist (2008) and Khan and Yoshino (2004) who all use a somewhat ad hoc framework to examine the PHE. The former two studies investigate, respectively, trends in U.S. pollution intensive trade and trends in European Union energy/ toxic intensive trade. They report mixed evidence on the pollution haven effect. The latter analyse of the composition of trade (in terms of its pollution-intensity) within and across trading blocs. The study reports some support for the PHE. In a related enquiry, Costantini and Crespi (2008) find that environmental regulation confers a comparative advantage in energy technologies.

¹³ There is also a related literature that focuses on plant/ industry location in general, one example of which is FDI Mulatu *et al.* (2010) that focuses on industry location in Europe.

¹⁴ While evidence on actual innovation offsets may be scarce, there seem to be ample evidence on the positive impact of regulation on eco process and product innovations through environmental R&D (Demirel and Kesidou, 2011 and Kesidou and Demirel, 2012).

¹⁵ I owe this point to an anonymous referee.

References

- Ambec, S., Cohen M.A., Elgie S., Lanoie, P. 2013 The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness? *Review of Environmental Economics and Policy*, 7: 2-22.
- André J, González P, Portiero N. 2009 Strategic Quality Competition and the Porter Hypothesis. *Journal of Environmental Economics and Management* 57: 182-194.
- Arouri M, Guglielmo C, Rault C, Sova R, Sova A. 2012 Environmental Regulation and Competitiveness: Evidence from Romania. *Ecological Economics* 81: 130–139.
- Arthur B. 1990 Positive feedbacks in the economy. *Scientific American* February: 80-85.
- Blomstrom M, Kokko A. 2001. Foreign direct investment and spillovers of technology, *International Journal of Technology Management* 22: 435-454.
- Babool A, Reed M. 2010 The impact of environmental policy on international competitiveness in manufacturing. *Applied Economics* 42: 2317–2326.
- Boltho A. 1996 The Assessment: International competitiveness. *Oxford Review of Economic Policy* 12: 1-16.
- Cave L, Blomquist G. 2008 Environmental policy in the European Union: Fostering the development of pollution havens? *Ecological Economics* 65: 253-261.
- Cole MA, Elliott RJR. 2003 Do Environmental Regulations Influence Trade Patterns? Testing Old and New Trade Theories. *World Economy* 26: 1163-86.
- Cole MA, Elliott RJR Shimamoto K. 2005 Why the Grass is not Always Greener: The Competing Effects of Environmental Regulations and Factor Intensities on US Specialization. *Ecological Economics* 54: 95-109.
- Cole MA, Elliott RJR Okubo T. 210. Trade, environmental regulations and industrial mobility: An industry-level study of Japan. *Ecological Economics* 69: 1995-2002..
- Cole MA, Fredriksson PG. 2009 Institutionalized pollution havens. *Ecological Economics* 68: 1239-1256.
- Costantini V, Crespi F. 2008 Environmental regulation and the export dynamics of energy technologies. *Ecological Economics* 66: 447-460.
- Copeland B, Taylor S. 2004 Trade, Growth, and the Environment. *Journal of Economic Literature* 42: 7-71.

- Dean J, Lovely M, Wang H. 2009 Are foreign investors attracted to weak environmental regulations? Evaluating the evidence from China. *Journal of Development Economics* 90: 1-13.
- Demirel P, Kesidou E. 2011 Stimulating different types of eco innovations in the UK: Government policies and firm innovations. *Ecological Economics* 70: 1546-1557.
- Di W. 2007 Pollution abatement cost savings and FDI inflows to polluting sectors in China. *Environment and Development Economics* 12: 775-798.
- Diakosavvas D. 1994. The impact of environmental policies on agricultural trade. *Journal of International Development* 6: 207-218.
- Ederington J, Minier J. 2003 Is environmental policy a secondary trade barrier? An empirical analysis. *Canadian Journal of Economics* 36: 137-154.
- Ederington J, Levinson A, Minier J. 2004 Trade liberalization and pollution havens. *Advances in Economic Analysis and Policy* 4, Article 6.
- Ederington J, Levinson A, Minier J. 2005 Footloose and pollution free. *The Review of Economics and Statistics* 87: 92-99.
- Ekins P, Speck S. 1999 Competitiveness and exemptions from environmental taxes in Europe. *Environmental and Resource Economics* 13: 369-396.
- Eskeland G, Harrison A. 2003 Moving to greener pastures? Multinationals and the pollution haven hypothesis. *Journal of Development Economics* 70:1-23.
- Fagerberg J. 1996 Technology and competitiveness. *Oxford Review of Economic Policy* 12: 39-51.
- Fagerberg, J, Mowery, J and Nelson, R. 2006 (Eds.). *Oxford Handbook of Innovation*, Oxford University Press, London, UK.
- Fredriksson GP, List JA, Millimet DL. 2003 Bureaucratic corruption, environmental policy and inbound US FDI: theory and evidence. *Journal of Public Economics* 87: 1407- 1430.
- Fullerton D. 2006. *The Economics of Pollution Havens*. Edward Elgar: Cheltenham.
- Greaker M. 2003 Strategic Environmental Policy; Eco-dumping or a Green Strategy? *Journal of Environmental Economics and Management* 453: 692–707.
- Grether J, Mathys NA and de Melo J. 2012. Unravelling the worldwide pollution haven effect. *The Journal of International Trade & Economic Development* 21: 131-162.
- Hanna R. 2010 US environmental regulation and FDI: evidence from a panel of US-based multinational firms. *American Economic Journal: Applied Economics* 2: 158–89.
- Helpman E, Krugman P. 1985 *Market Structure and Foreign Trade*. MIT Press: Cambridge.

- Iraldo, F, Testa, F, M.melis, M and Frey, M. 2011. A literature review on the links between environmental regulation and competitiveness. *Environmental Policy and Governance*, 21, 210–222.
- Jaffe A, Peterson S, Portney P, Stavins R. 1995 Environmental regulation and the competitiveness of US manufacturing: what does the evidence tell us? *Journal Economic Literature* 33: 132-163.
- Javorcik B, Wei S. 2004 Pollution havens and foreign direct investment: dirty secret or popular myth? *The B.E. Journal of Economic Analysis & Policy* Article 8.
- Kahn M. 2003 The geography of US pollution intensive trade: evidence from 1958 to 1994. *Regional Science and Urban Economics* 33: 383-400.
- Kahn M, Yoshino Y. 2004 Testing for pollution havens inside and outside of regional trading blocs. *Advances in Economic Analysis & Policy* 4 Article 4.
- Kee H, Ma H, Mani M. 2010 The effects of domestic climate change measures on international competitiveness. *The World Economy* 33: 820–829.
- Kellenberg DK. 2009 An empirical investigation of the pollution haven effect with strategic environment and trade policy. *Journal of International Economics* 78: 242-255.
- Kesidou P, Demirel E. 2012 On the drivers of eco innovations: Empirical evidence from the UK. *Research Policy* 41: 862-870.
- Kheder S, Zugravu N. 2012 Environmental Regulation and French firms location abroad: An economic geography model in an international comparative study. *Ecological Economics* 77: 48-61.
- Keller W, Levinson A. 2002 Pollution abatement costs and direct foreign investment inflows in the United States. *Review of Economics and Statistics* 84: 691–703.
- Kirkpatrick C and Shimamoto K. 2011 The effect of environmental regulation on the location choice of Japanese foreign direct investment. *Applied Economics* 40:1399-1409.
- Kokko A, Tanssini R, and Zejan M.C. 1996. Local technological capability and productivity spillovers from FDI in the Uruguayan manufacturing sector, *The Journal of Development Studies* 32: 602-611.
- Kozluk T. Zipperer V. 2014. Environmental policies and productivity growth: a critical review of empirical findings, *OECD Journal: Economic Studies* 1:155-185.
- Krugman P. 1996 *Pop Internationalism*. The MIT Press: Cambridge.
- Lankoski L. 2010 Linkages between Environmental Policy and Competitiveness, OECD, Environment Working Papers No. 13, www.oecd.org/dataoecd/0844392874.pdf.

- Leamer E. 1984 *Sources of international comparative advantage*. The MIT Press: Cambridge.
- Levinson A, Taylor MS. 2008 Unmasking the pollution haven effect, *International Economic Review* 49: 223-254.
- List JA, Co C. 2000 The effects of environmental regulation on foreign direct investment. *Journal of Environmental Economics and Management* 40: 1-20.
- List JA, McHone WW, Millimet DL, Fredriksson PG. 2003 Effects of environmental regulations on manufacturing plant births: evidence from a propensity score matching estimator. *Review of Economics and Statistics* 85: 944–952.
- Ljungwall C and Linde-Rahr M. 2005 Environmental Policy and the location of foreign direct investment in China, Working PaperNo. E009, China Centre for Economic Research.
- Manderson E, Kneller R. 2012 Environmental Regulations, Outward FDI and Heterogeneous Firms: Are Countries Used as Pollution Havens? *Environmental and Resource Economics* 51: 317-352.
- Martin R, Muûls M, de Preux L, Wagner U. 2012 Industry Compensation Under Relocation Risk: A Firm-Level Analysis of the EU Emissions Trading Scheme. *CEP Discussion Paper* 1150.
- Millimet DL, Roy J. 2015 Three New Empirical Tests of the Pollution Haven Hypothesis When Environmental Regulation is endogenous. *Journal of Applied Econometrics* DOI: 10.1002/jae.2451
- Mohr RD. 2002 Technical Change, External Economies, and the Porter Hypothesis. *Journal of Environmental Economics and Management* 43: 158–68.
- Mohr RD, Saha S. 2008 Distribution of Environmental Costs and Benefits, Additional Distortions, and the Porter Hypothesis. *Land Economics* 84: 689-700.
- Mulatu A, Florax R, Withagen C. 2003 Environmental regulation and competitiveness: an exploratory meta-analysis. In *Empirical Modeling of the Economy and the Environment* Boehringer C, Loeschel A (eds.). Physica Verlag: Heidelberg, pp 23–54.
- Mulatu A, Florax R, Withagen C. 2004 Environmental regulation and international trade: empirical results for Germany, the Netherlands and the US, 1977–1992, *The B.E. Journal of Economic Analysis & Policy, Contributions* 3 Article 5.
- Mulatu A, Gerlagh R, Rigby D, Wossink A. 2010 Environmental Regulation and Industry Location in Europe. *Environmental & Resource Economics* 45: 459-479.
- Mulatu A. 2016. On the concept of 'competitiveness' and its usefulness for policy. *Structural Change and Economic Dynamics* 36: 50-62.

- Neary P. 2003 Competitive versus comparative advantage. *The World Economy* 26: 457-470.
- Neary P. 2006 Measuring Competiveness. *The Economic and Social Review* 37: 197-213.
- Palmer, K., Oates, W., and Portney, P. 1995. Tightening environmental standards: the benefit-cost rule or the no-cost paradigm? *Journal of Economic Perspectives*, 9, 119-132.
- Poelhekke S. and van der Ploeg, F. 2015 Green Havens and Pollution Havens. *The World Economy*, 38: 1035–1178.
- Porter M. 1990 *The Competitive Advantage of Nations*. Collier Macmillan: London.
- Porter M, Linde C van der. 1995 Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives* 9: 97-118.
- Porter M, Delgado M, Ketels, C and Stern S. 2008. Moving to a New Global Competitiveness Index, in Porter, M. and K. Schwab (Eds.) *The Global Competitiveness Report*, World Economic Forum, Geneva, pp. 42-63.
- Porter M, Rivkin J. 2012a The looming challenge to the U.S. competitiveness. *Harvard Business Review* March: 55-62.
- Porter M, Rivkin J. 2012b Choosing the U.S. *Harvard Business Review* March: 81-93.
- Porter M, Rivkin J, Desai M, Raman M. 2016 Problems Unsolved and a Nation Divided. Harvard Business School Survey on US Competitiveness, Harvard Business School: Harvard.
- Reinert E. 1995 Competitiveness and its predecessors – a 500-year cross-national perspective. *Structural Change and Economic Dynamics* 6: 23-42.
- Reinert, E. 2009 Emulation v. Comparative Advantage: Competing and Complementary Principles in the History of Economic Policy. In M. Cimoli, G. Dosi and J. Stiglitz (Eds.), *Industrial Policy and Development: The Political Economy of Capabilities Accumulation*, Oxford University Press, Oxford, pp. 79-106.
- Spatareanu M. 2007 Searching for Pollution Havens: The Impact of Environmental Regulations on Foreign Direct Investment. *The Journal of Environment Development* 16:161-182.
- Subramanian A, Mattoo A. 2013 *Greenprint: A New Approach to Cooperation on Climate Change*. Brookings Institution Press: Washington DC.
- Tobey J. 1990 The impact of domestic environmental policy on international trade: an empirical test. *Kyklos* 43: 191-209.

- Tyson L. 1992 *Who's Bashing Whom? Trade Conflict in High-Technology Industries*.
Institute of International Economics: Washington, DC.
- van Beers C , van den Bergh JCJM. 1997 An empirical multi-country analysis of the impact
of environmental regulation on foreign trade flows. *Kyklos* 50: 29-40.
- van Beers C , van den Bergh JCJM. 2003 Environmental regulation impacts on international
trade: Aggregate and sectoral analysis with a bilateral trade flow model. *International
Journal of Global Environmental Issues*, 3, 14-29.
- Vietor, R.H.K. 2007. *How countries compete: Strategy, structure, and government in the
global economy*, Harvard Business Press: Cambridge.
- Waldkirch A, Gopinath M. 2008 Pollution Control and Foreign Direct Investment in Mexico:
An Industry-Level Analysis, *Environmental and Resource Economics* 42: 289-313.
- Wlaker W.R. 2013. The transitional costs of sectoral reallocation: evidence from the Clean
Air Act, *Quarterly Journal of Economics* :1787-1835.
- Weintraub E. 2013 Neoclassical Economics. In *The Concise Encyclopedia of Economics*.
Library Economics
Liberty <http://www.econlib.org/library/Enc1/NeoclassicalEconomics.html>.
- (The) World Bank 2008. *The Growth Report: Strategies for Sustained Growth and Inclusive
Development*, World Bank, Washington DC.
- Xing YO, Kolstad CD. 2002 Do lax environmental regulations attract foreign investment?
Environment and Resource Economics 21: 1–22.

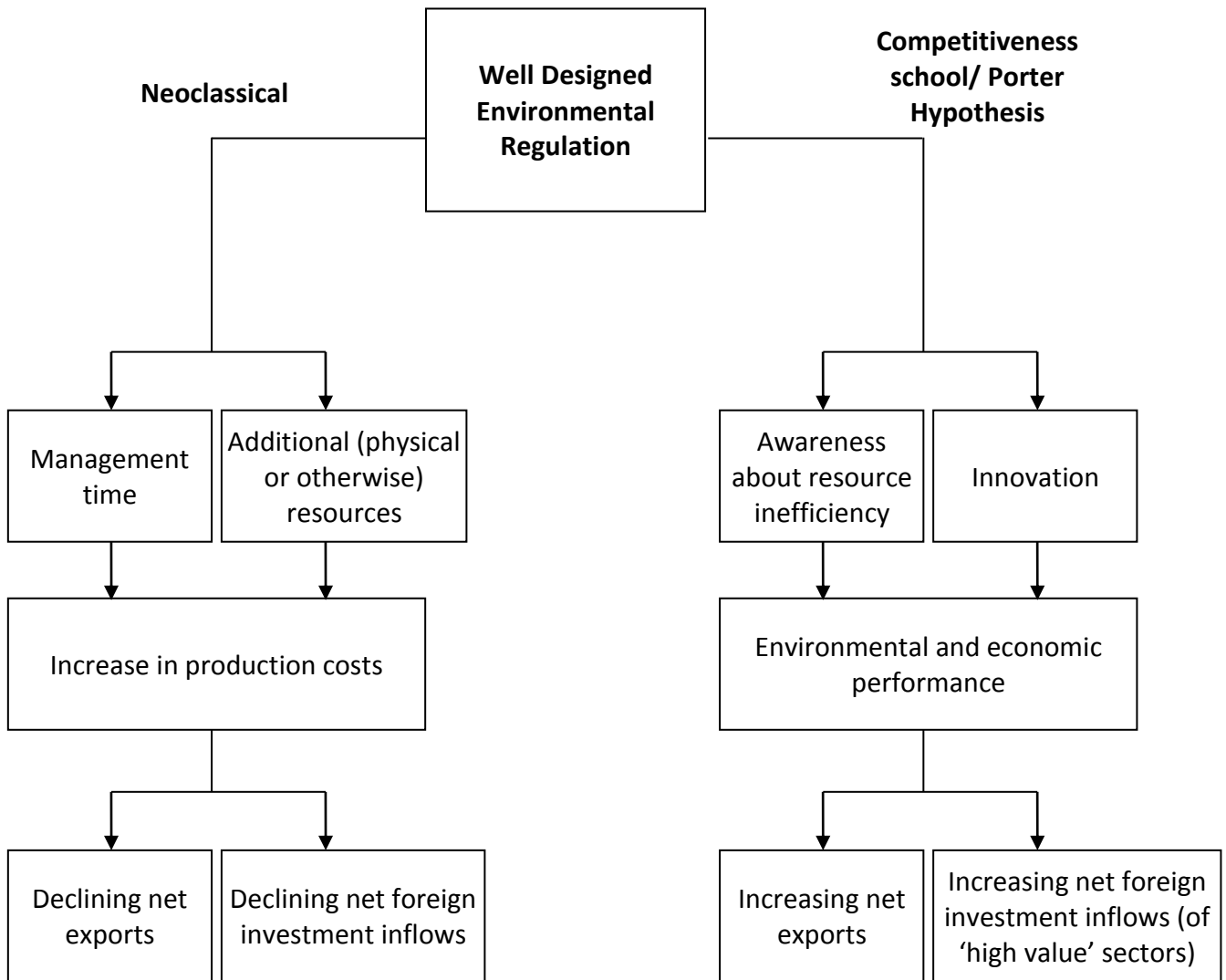


Figure 1 Schematic representation of the two hypotheses on environmental regulations and competitiveness

Table 1 Select review of empirical papers on environmental regulation and trade and investment flows

Author(s)	Type of data	Addressing endogeneity	Trade/FDI flows to/from	Evidence of PHH
Trade flows				
Cole and Elliott (2003)	Cross section	No	US net exports	Mixed
Ederington and Minier (2003)	Panel	Yes	US net imports	Yes
Mulatu et al. (2004)	Panel	No	German, Netherlands & US net exports	Mixed
Ederington et al. (2004)	Panel	Yes	US net imports	No
Cole et al. (2005)	Panel	Yes	US net exports	No
Ederington et al. (2005)	Panel	No	US net imports	Yes
Levinson & Taylor (2008)	Panel	Yes	US net exports	Yes
Babool and Reed (2010)	Panel	No	OECD net exports	Mixed
Cole et al. (2010)	Panel	No	Japan's net imports	Yes

Author(s)	Type of data	Addressing endogeneity	Trade/FDI flows to/from	Evidence of PHH
FDI flows				
List and Co (2000)	Cross-section	No	To US from various	Yes
Keller and Levinson (2002)	Panel	Yes	To US from various	Yes
Xing and Kolstad (2002)	Cross-section	Yes	To various from US	Yes
Dean et al. (2003)	Cross-section	No	To China from various	Mixed
Eskeland and Harrison (2003)	Panel	No	To developing countries from US	No
Fredriksson et al. (2003)	Panel	Yes	To US from various	Yes
Javorcik and Wei (2004)	Cross-section	No	To Eastern Europe from various	Mixed
Cole and Elliot (2005)	Panel	Yes	To Brazil and Mexico from US	No
Ljungwall and Linde-Rahr (2005)	Panel	No	To China's provinces from various	Mixed
Di (2007)	Cross-section	No	To China's provinces from various	Yes

Author(s)	Type of data	Addressing endogeneity	Trade/FDI flows to/from	Evidence of PHH
Spatareanu (2007)	Cross-section	No	To Europe from various	Yes
Walckirch and Gopinath (2008)	Cross-section	No	To Mexico from various	Mixed
Dean et al. (2009)	Cross-section	No	To China from various	Mixed
Cole and Fredriksson (2009)	Cross-section	Yes	From various to various	Yes
Kellenberg (2009)	Panel	Yes	To various from US	Yes
Hanna (2010)	Panel	No	To various from US	Yes
Kirkpatrick and Shimamoto (2011)	Cross-section	No	To various from Japan	No
Manderson and Kneller (2012)	Cross-section	No	To various from UK	No
Kheder and Zugravu (2012)	Cross-section	Yes	To various from France	Mixed
Millimet and Roy (2015)	Panel	Yes	To US from various	Yes
Poelhekke and van der Ploeg (2015)	Panel	Yes	To various from Netherlands	Mixed