CAN MARKET FORCES SOLVE ENVIRONMENTAL PROBLEMS? NEOCLASSICAL VS. AUSTRIAN ANALYTICS

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Discuss if environmental problems will be solved by market forces and do not need government intervention

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Abstract

This paper shows that a free market solution for environmental problems exists, which can solve environmental problems and therefore government intervention is not necessary. To start with, the methodological differences between the Neo-classical and Austrian School of Economics are introduced. While Neo-classicals are seeking efficiency, Austrians are concerned about removing interpersonal conflicts. Based on that, it will be shown how taxes and tradable permits could theoretically remove inefficiency but fail in eliminating interpersonal conflicts. In order to give free market solutions, privatisation, 'polluter pays' and the 'first comes first served' principle are evaluated. In the end, it is shown how a definition and enforcement of property rights could successfully substitute government interventions.

Introduction

When arguing about the environment from an economic perspective, neo-classical microeconomics is by far the predominant methodology applied. For most writers it appears that the free market offers no satisfying solution to environmental problems. However, this is far from the truth because an Austrian Theory of Environmental Economics already exists. In order to introduce the Austrian perspective on environmental issues, the first part detects the fundamental methodological differences between Neo-classical and Austrian Economics. The second part evaluates the two traditional policy instruments, taxes and tradable permits. The third part sets up three Austrian solutions to the environmental problem: privatisation, 'polluter pays' and the 'first comes first served' principle.

Neo-classical Economics

From a neo-classical perspective, economics is defined as the allocation of scare resources among alternative ends. Human beings are rational and the concept of profit maximising is accepted. Neo-classical economics is a 'positive' theory because it is subjecting economic phenomena to study by similar methods to those of natural science. It uses mathematics and statistics since many economic variables are seen as quantifiable. Neo-classical economics knows four market types: monopoly, monopolistic competition, oligopoly and perfect competition[2]. As we shall see later, only in perfect competition markets work optimal[3]. In any other cases, the market fails and needs to be corrected.

A sub branch of Neo-Classical Economics is Welfare Economics to which all neo-classical assumptions can also be employed. Welfare Economics is normative because value judgments about the desirability of a certain outcome are made. Its main purpose is to study the possible effects of various economic policies on the welfare of society. Therefore, the objective is to maximise welfare, respectively allocate and distribute scarce resources in the 'best' way.

However, the problem involved is that welfare cannot be measured. Indifference curves[4] can only show if an individual is 'better' or 'worse off' but interpersonal comparisons of welfare cannot be made. This means that the Utilitarian practise is not employable because it is not measurable. Therefore, it is not possible to assert objectively.

To avoid this problem, Neo-classical and Welfare economists introduced a set of assumptions, which is known as 'optimality' conditions based on the Paretian premise. The 'social optimum' (also known as 'economic efficiency' or 'Pareto optimality') is a situation in which it is impossible, by changing the existing resource allocation or distribution of output, to make an individual better off (in his own estimation) without making some other individual worse off. This leads to the necessary assumptions

[2] Perfect Competition: unlimited amount of firms without market power, which are all price makers rather than price takers.
[3] 'Optimal' means that markets work economic efficient. Economic efficiency is met when production and distribution efficiency is reached at the same time, which is the condition concerned with determining what the given bundle of goods and services should be. Under this condition no change in the goods total or its distribution can make one person better off without harming another.
[4] A curve that shows all combinations of goods or services that provides the same level of utility.

of ‘economic efficiency’, which require both, distribution and exchange efficiency (for more details see Appendix 1).

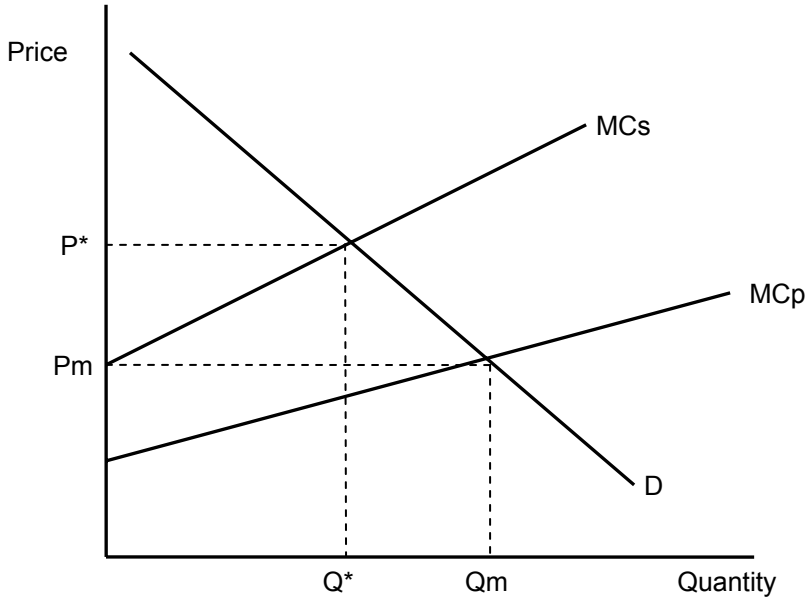
Externalities

Nevertheless, ‘economic efficiency’ can only be reached in perfect competition when P = MC (first best solution) and only then markets are seen as superior. Conversely, markets fail (are inefficient) if there are externalities like pollution because then P ≠ MC anymore. Externalities occur whenever welfare of some agent depends not only on his or her activity, but also on activities under control of some other agents (Tietenberg 2003). For example, a steel factory and a hotel are located at the same river. The steel factory uses the river to dump its waste while the hotel uses the river for recreation. The increased waste in the river imposes an external cost on the hotel, which the steel factory could not be counted upon to consider appropriately in deciding the amount of waste to dump. Therefore, it could be expected that the steel factory dumps too much waste in the river and an efficient allocation of the river would not be attained.

Graph 1[5] illustrates the effects of external costs on the steel factory. During the production process, the factory produces steel and pollution. The demand for steel is shown by the demand curve (D) and the private marginal cost pf producing steel by the MCp curve. Of course, society considers cost of pollution and cost of producing steel and therefore the social marginal cost function (MCs) includes both of these costs. If pollution was not controlled the production of steel would be at Qm because this maximises private producer surplus but this would not be efficient since net benefit is maximised at Q*, not Qm. This clearly shows that the market allocation of commodities is causing pollution externalities:

1. Too much output of the commodity is produced
2. Too much pollution is produced
3. The price of pollution-causing products is too low
4. External costs do not give incentives to cut pollution
5. Recycling is inefficient in comparison to release pollution into the environment.

[5] Source: Tietenberg (2004)



Graph 1: Maximise Net Benefits

When discussing externalities it has to be recognised that there are negative and positive externalities, depending on the benefited or damaged party. Moreover, pecuniary externalities exist, where the external effect is transmitted through altered prices[6]. Therefore, pollution is not a pecuniary externality because the price mechanism does not reflect the increased waste load. It is also possible that special circumstances lead to externalities. In general, it can be distinguished between other property rights regimes[7], public goods[8] and last but not least imperfect market structures, such as monopoly, as well as government failure.

In order to maintain 'economic efficiency' pollution costs have to be internalized, i.e. have to be taken into account by the polluter. Nevertheless, for goods like air or water the property right structure is not clear. Therefore it is the duty of the government, which is assumed to operate in the public interest, to correct the market failure (internalise the costs) and bring the economy back to efficiency. Nonetheless, the first best solution is out of reach, governments should bring the economy as close to it as possible (second best solution). To fulfil that task governments have two major instruments; centralised taxes (based on the Pigovian Tax) as well as decentralised tradable permits (based on the Coase Theorem) (Field 1994). Both instruments will be evaluated through this paper.

Austrian Economics

To understand how a free market would solve environmental problems it is necessary to be aware of the methodological fundamentals of the Austrian School of Economics. Austrian theorists see

[6] For example, a company moves into a certain area and increasing demand pushes up the rent. This is a negative effect for all those who have to pay rent (external diseconomy). However, this is not a market failure since higher rents reflect the scarcity of land.
[7] For example common-property (resource are owned in common rather than privately) and res nullis resource (where no individual or group has legal power to restrict access).
[8] Public goods: Nonexclusive and no rival

economics as the study of human action (Praxeology[9]). Firstly, the fundamental axiom is that individuals act purposefully to achieve chosen ends. Consequently, the ultimate end of action is always the satisfaction of some desire of the acting man (Mises 1949). Hence, efficiency is 'praxelogical' and an individual goal seeking process rather than value maximizing (Cordato 1980). Inefficiency only arises when means are chosen that are inconsistent with the desired goal. Secondly, costs are subjective because "(…) the private experience of an individual [is] (…) the sole foundation of factual knowledge"[10]. Thus, interpersonal utility comparisons are methodological invalid. Thirdly, Austrian economics depends on methodological individualism, which means that all statements about groups are reducible to statements about the behaviour of the individuals composing those groups in their interaction (Shand 1984). This is why Austrians, as well as Karl Popper[11], reject holism[12] and macroeconomics dealing with interacting aggregates. Furthermore, Austrians see inequality as positive and as enrichment in variety. Fourthly, Austrian economics rejects concepts of scientism in economics because facts of social science are subjective and not susceptible to the object methods of natural science (Hayek 1952). Finally yet importantly, there is an inherent unpredictability and determinacy in human action, which always leads to a degree of uncertainty and risk. Therefore, entrepreneurs play a vital part for Austrians in the economy because they take the risk in order to make profits.

In contrast to neo-classical economics, Austrian economists start their analysis with the assumption of an unhampered market. Property rights[13], private ownership as well as free and competitive markets (absence of interventions and regulations) are the basic assumptions for a working economy, where the market automatically allocates scarce resources and individuals voluntarily trade with each other, driven by their profit motives. According to that, pollution is not a market failure but an inter-personal conflict of humans over the use of physical resources. Furthermore humans cannot harm the environment; they can just exchange it that it harms others who might be planning to use it for a conflicting purpose (Cordato 1980, 1997). Henceforward Robinson Crusoe was not a polluter since his plan execution did not interfere with anybody else. In sharp contrast to neo-classical, Austrian economics is about resolving inter-personal conflicts rather than correcting market failures.

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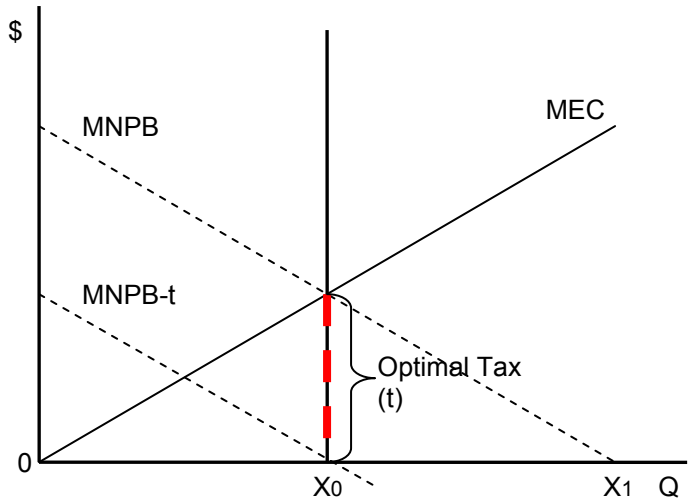
[9] Ludwig von Mises. *Human Action* (1940)
[10] Alexander H. Shand. *The Capitalist Alternative* (1984) p.3
[11] Sir Karl Popper (1957)
[12] Holism (the existence of social wholes, which have purposes or needs)
[13] As a basis for property rights Rothbard quotes Professor Patterson's definition of natural law: "Principles of human conduct that are discoverable by 'reason' from the basic inclinations of human nature, and that are absolute, immutable and of universal validity for all time and places" (Rothbard, M. (1982) *Ethics of Liberty*. USA: Atlantic Highlands, N.J.: Humanities Press). This follows that "man has an inalienable right to his own mind and body, and as an extension, those things which he justly acquires through the use of his labour (in other words, excluding property acquired by theft or violence)" (Mayer, C. (1999) *Free Speech*. USA: Mises Daily Article).

Political Instruments

As previously shown, from a neo-classical perspective markets do not 'internalize' pollution and are so due to fail, which makes "the case for some sort of government intervention is particularly strong."[14] Two political instruments are applied, taxes and tradable permits. After an evaluation of the two instruments the questions arises if they are a real improvement compared to a free market system.

Pigovian Tax

Taxes are one of the oldest forms of pollution control ever since Arthur Cecil Pigou developed the first approach in 1912. The idea of the Optimal Pigovian Tax is simple: internalize costs of pollution. This can be done by imposing a tax of t on each unit produced (Graph 2). Consequently, this shifts MNPB (marginal net private benefit) to the left. Thus, the marginal benefit to the firm is reduced by t from X_1 (competitive output) to X_0, which is the social efficient output, i.e. the optimal level of pollution (MCp = MPp) because the 'Damage Function' (MEC), which displays pollution in monetary terms, is equal to the social efficient output (X_0).



Graph 2: Optimal Pigovian Tax

Weaknesses

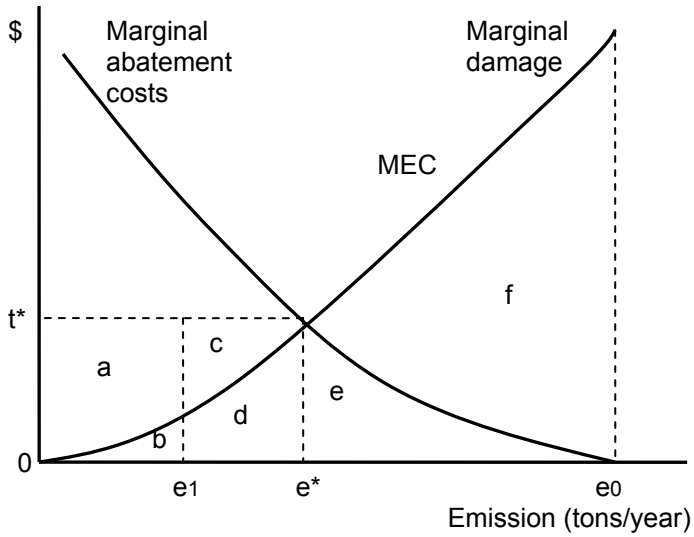
As pleasant as this approach might look like, it is nearly impossible to calculate the Pollution-Damage-Function because too much information is necessary[15]. Furthermore, the MNPB function has to be known, which is due to asymmetric information also impossible. Lastly, taxes cannot be applied internationally. For example, 85% of Norway's pollution comes from England. Thus, taxing a whole country is not possible.

[14] Tietenberg, T.H. (2003) *Environmental and natural resource economics*. USA: Pearson Education, Inc. p 360

[15] To calculate the Damage-Function information about economics efficiency and pollution of polluter, pollution concentration in environment and pollution exposure must be accessible in monetary terms.

Efficient Emission Tax

Beside these weaknesses economists uses the Pigovian Tax as a basis for a modified Efficient Emission Tax. The essence of this approach is provide an incentive for the polluter themselves to find the best way to reduce emission (Field 1994). Graph 3[16] indicates that at a tax rate of t* emissions are e*, and the marginal damage equals marginal abatement costs. Total costs for companies are abatement costs and tax payments (a + b + c + d). Therefore, the reduction of emission from e0 to e* has eliminated damages of (e + f), while the remaining damages (b + d) are less than the firms pay taxes.



Graph 3: Efficient Emission Tax.

The advantage of taxes is that they attack the pollution problem at its source. According to Field (1994), the tax approach also benefits from two efficiency aspects: Firstly, if all sources are subject to the same tax, they will adjust their emission rate so that the equimarginal rule is satisfied. Secondly, emission taxes produce strong incentives to innovate, to discover cheaper ways of reducing emissions. Last but not least, taxes provide a source of revenue for public authorities.

Austrian Critics

For Austrians taxes are not only dissatisfying but also harmful and dangerous. First, assumptions of perfect competition are not realistic and therefore useless. Secondly, the measurement of spill over costs is necessary but costs are subjective and exist only in the mind of the decision maker (Buchanan 1969). Thirdly, opportunity costs cannot be measured and therefore the correct outcome is unknown. Fourthly, static equilibrium as well as cost/benefit analysis is based on out-of-date data in an always changing, dynamic world and consequently a miscalculation is inevitable. Bate and Morris (1994) question the efficiency of governments and warn that in deed some special interest groups, like climatologists, economists and environmental groups would gain from increased government intervention in the energy market. Finally, they conclude, “such railroading of investment and central

[16] Source: Field (1994)

planning of environmental and development goals is almost certain to be less efficient and less productive than private sector investment"[17].

Coase Theorem

Graph 1 showed that the social optimal level of economic activity does not coincide with the private optimum if there are external costs present. However, Roland Coase (1960) propounded that if markets may not secure the optimal amount of externality they "can be very gently 'nudged' in that direction without the necessity for full-scale regulatory activity" [18]. Consequently, the optimal amount of externality can be reached if property rights are clearly defined because parties can bargain. Here property rights are defined absolute and the right to use a resource, circumscribed by the generally accepted rules of society[19].

Graph 4[20] shows the basic principal of the Coase Theorem. In an unregulated market, the polluter would try to operate in Q, because here his profits are maximised but the social optimum is at Q*. If the sufferer has the property rights, he has the right not to be polluted, which is the origin of Graph 3. Nonetheless, both parties are free to bargain over the level of pollution, i.e. the polluter can compensate the sufferer in order to pollute. If they move from 0 to d, the polluter would gain area 0abd, the sufferer area 0cd, which is a 'Pareto improvement'[21]. Since 0abd > 0cd there is more potential for bargaining. The same is true for a move from 0 to e however, a move to the right of Q* is not practicable since the polluter's net gains become lessen than the sufferer's losses. This means the polluter cannot compensate the sufferer to move beyond Q*. The same principle is relevant if property rights lay with the polluter, here the starting point is Q and trough bargaining the sufferer can compensate the polluter for less pollution. Again, this move tends towards Q*.

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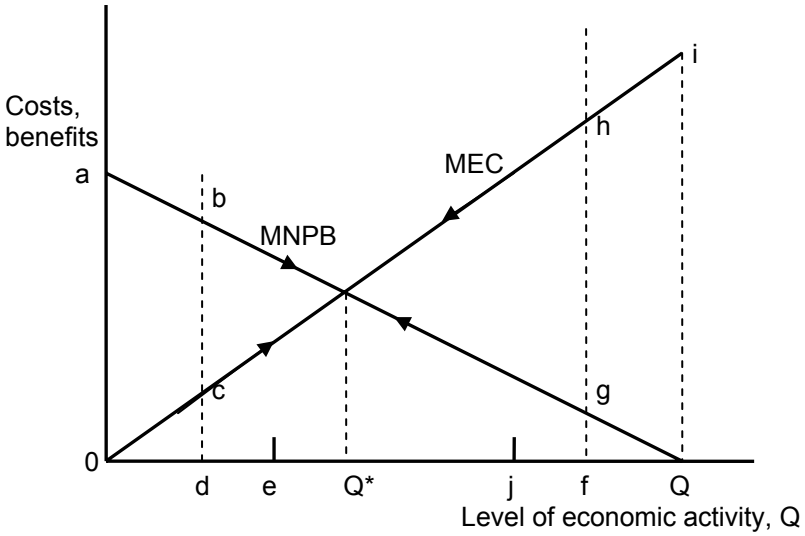
[17] Bate, R., Morris, J. (1994) *Global Warming Apocalypse or Hot Air?* Great Britain: Institute of Economic Affairs (IEA)

[18] Pearce, D.W., and Turner, R.K. (1990) *Economics of Natural Resources and the Environment*, Johns Hopkins University Press, Baltimore. p 70

[19] Note the fundamental differences to the liberal definition since the "generally accepted rules of society" means that for example the right to cultivate land does not usually carry with it the right to grow opium poppies (Pearce and Turner 1990). From a liberal point of view however, individuals are free to use their properties in any way they wish, as long as this does not violate the property rights of someone else [see footnote 12]. Hence, cultivating land and growing opium poppies is a legal action.

[20] Pearce and Turner (1990)

[21] 'Pareto improvement' since at least one party is better off without the other party being worse off



Graph 4: Optimal pollution by bargaining

'Positively', "regardless of who holds the property rights, there is an automatic tendency to approach the social optimum (…) [thus] we have no need for government regulation of externality, for the market will take care of itself."[22] 'Normatively', property rights should be assigned to the contesting parties yo that the value of production is maximized.

Critics of the Coase Theorem

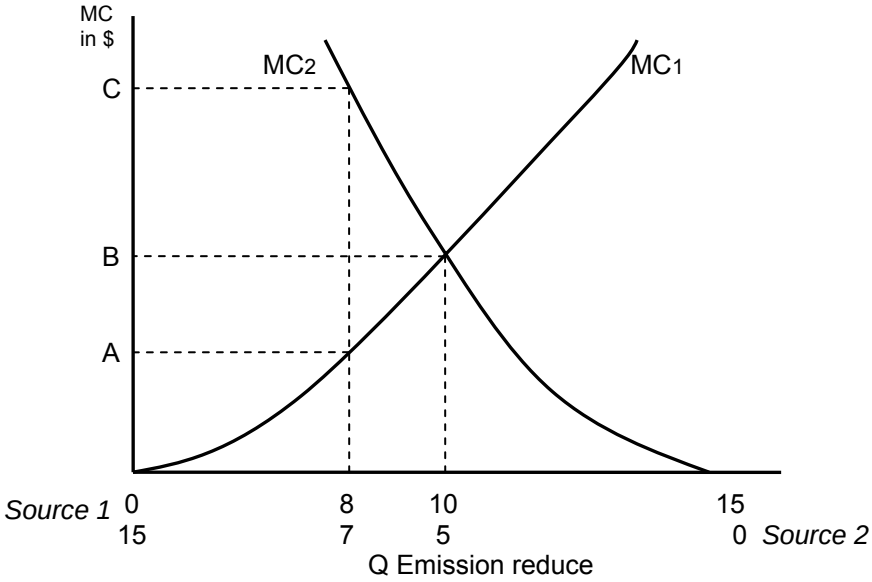
Beside the insightful result the Coase Theorem delivered, it has a large number of weaknesses, which question the usefulness of this theory. Firstly, the Coase Theorem assumes perfect competition where MNPB = P - MC and, hence, (MNPB = MEC) requires (P = MSC). In imperfect competition MR ≠ P because D > MRC. This follows that the bargaining solution does not apply under imperfect competition (see Appendix 2 for more details). Secondly, the real world delivers hardly any examples of the theorem because there are obstacles to bargain in form of transaction costs (Pearce and Turner 1990). Thirdly, no bargain may take place because the pollution affects individuals, who are not born yet and it is impossible to bargain with future generations. Fourthly, it might too expensive or even impossible to find the polluter (e.g. for air and water pollution as well as acid rain) and thus bargaining is not possible.

Tradable Permits

In order to use a decentralised, market-based concept, which profits from the insights of the Coase Theorem, but overcomes its weaknesses, economists developed tradable permits. The government issues permits in exactly the number needed to produce the desired emission level. They give or sell its holder the right to pollute for a certain amount and they are freely transferable; they can be bought and sold on the market, even internationally, thus they act as property rights.

[22] Pearce, D.W., and Turner, R.K. (1990) *Economics of Natural Resources and the Environment*, Johns Hopkins University Press, Baltimore. p 73

As Graph 5[23] illustrates, this leads automatically to a cost-effective allocation because equilibrium for an emission-permit system is the cost-efficient allocation. Suppose that Source 1 has 7 permits. It must control 8 units, since it has 15 units of uncontrolled emission. A second source (Source 2) has remaining 8 permits, which means it has to clean up 7 units. Accordingly both parties have an incentive to trade. Since marginal cost of control for source 2 (C) is higher than that for source 1 (A), source 2 could lower its cost through buying a permit from source 1 at a price lower than C. Ever since source 1 is better off selling a permit for a price greater than A the requirements for trade exist. Trade would take place until permit price is equal C because that is the marginal value of that permit to both sources.



Graph 5: Tradable Permits and cost-effectiveness

Austrian Critics

While the Coase Theorem might seem to be similar to the Austrian theory, there are fundamental differences. Both, the positive and the normative claim of Coase must be rejected (Hoppe 2004) because firstly, for the value of social production it matters how property rights are assigned and secondly, property rights help to remove interpersonal conflicts and cannot be allocated to maximise the value of output[24].

According to the liberal definition of property rights and pollution, tradable permits harm market forces, violate property rights and only help to achieve political determined goals (Cordato 1980, 1997). Firstly, assume a cement factory is polluting the air, which affects property owners living next to it. In a free market system, this is a violation of property rights of the homeowners because “air pollution is a

[23] Source: Tietenberg (2004)

[24] Hoppe (2004) names three reasons why Coase’s definition is methodological wrong from the Austrian perspective: Firstly, since interpersonal utility comparisons are scientifically impossible it cannot be determined who maximises the value of production. Secondly, even so they are made, different circumstances will lead to a re-distribution of property titles. Thirdly, an ethic must allow to make decisions about "just or unjust" prior to one's actions.

private nuisance generated form one person's landed property onto another and is an invasion of the airspace appurtenant to land and, often, of the person of the landowner"[25]. Therefore, the victim can sue the aggressor[26], which solves their interpersonal conflict. Secondly, in opposite to that, tradable permits are licenses to violate property rights since the real problem is not air pollution itself but that emission eventually lands on someone's property. Thirdly rules of conducts need to be ends independent in order not to be abused by political authorities. In other words, rules have to support each individual in order to maximise his chances to accomplish his own goals (Hayek 1952). Clearly, tradable permits alter individual's incentives and are therefore inconsistent with the free market.

Privatisation

One free market solution for environmental problems is privatisation. Since Austrians see the pollution problem in a lack of defined property rights, broad-scaled privatisation of the public sector would clearly solve this dilemma. If most public goods were privatised, the property right structure was clear and pollution problems could be solved on an interpersonal base. It is not too abstract to think about privatised public goods like streets, motorways and lakes as well as public services as education[27], healthcare, social security[28] and waste disposal[29]. Moreover, as all Austrian theorists have been emphasising, private ownership dramatically increases efficiency and responsibility of resources usage since central planning is predestined to fail (Hayek 1952). However, some problems persist when thinking about large public goods. Nonetheless, as Walter Block (1989) demonstrates, it would be even possible to privatise what seems to be unprivatizable, namely the oceans, seas and other larger bodies of water. Although he admits that this is "a far more radical [solution]",[30] he explains how modern techniques might help in "setting up boundaries in bodies of water"[31]. However, form a neo-classical point of view a free market might lack in equity since the current income distribution has to be accepted before people start competing freely.

Polluter Pays

When all property rights are defined, a 'polluter pays' principal rooted in the enforcement of these property rights makes sense. According to liberal theory, "(…) everyone should be able to do what he

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[25] Rothbard, M. (1982) *Law, Property Rights, and Air Pollution*. USA: The Cato Journal (vol. 2, no. 1)

[26] According to liberal law, "the tortfeasor or criminal is to be strictly liable for his aggression, with no evasion of liability permissible on the basis of "negligence" or "reasonability" theories. However, the liability must be proven on the basis of strict causality (…) beyond reasonable doubt. (…). These principles should apply to all torts, including air pollution". [Rothbard, M. (1982) *Law, Property Rights, and Air Pollution*. USA: The Cato Journal (vol. 2, no. 1)]

[27] Rothbard, M. [1971] (1999) *Education. Free and Compulsory*. USA: The Ludwig von Mises Institute.

[28] For the unbelievable success of the privatised Chilean private security system see Piñera, J. (1996) Empowering Workers: The Privatization of Social Security in Chile. USA: Cato Journal, Vol. 15, Nos. 2-3. and 'International Center for Pension Reform': www.josepinera.com

[29] For an in-depth analysis of how a private waste disposal could 'internalize' costs of bin and be much more efficient than a public system see Block, W. (1998) *Environmentalism and Economic Freedom: The Case for Private Property Rights*. Journal of Business Ethics. Netherlands: Kluwer Academic Publishers.

[30] Block, W. (1989) *Economics and the Environment: A Reconciliation.* Canada: The Fraser Institute. p 292

[31] Block, W. (1989) *Economics and the Environment: A Reconciliation.* Canada: The Fraser Institute. p 293

likes, except if he commits an overt act of aggression against the person and property of another." [32] Thus, when the steel factory dumps its waste in the river and that violates the property rights of the hotel (as previously described) the polluter can be sued and has either to eliminate pollution, confine it to his own property or compensate the victim that the grievance is truly settled (Cordato 1980, 1997). It is important to realise that no third party is involved, the victim is compensated and therefore costs are truly internalized. Hereby the responsibility for ending conflict belongs to the polluter. Importantly, no central planning is involved because no authority has to determine 'efficient' levels.

As logical this approach might appear, there are also problems involved because to make a polluter pay he has to be clearly identified. For environmental problems like ozone layer, acid rain or global warming it might be impossible to find the culprit and therefore interventions are needed. Nevertheless, there are example were the environment was improved without interventions: increased fuel efficiency in automobiles, consumer adoption of oil and natural gas for the heating of homes, and the introduction of new energy sources such as nuclear and solar power. Entrepreneurs, in their desire to attain the highest yield of energy per unit of resource, were voluntarily reducing air pollution at a dramatic rate[33] (Weinert 1998).

First Come First Served

If, however, property rights are not clearly defined the 'polluter pays' principle does not work. Here Coase, Demsetz and Posner argued that whatever increases social wealth is just[34] and the right to use a resource goes to the person whose use will maximise the overall value of production (Cordato 2004). However, this is in sharp contrast to the 'first come first served' principle, which stats that "where a 'polluter' has come first to the pollution and has preceded the landowner in emitting air pollution or excessive noise onto empty land, he has thereby homesteaded a pollution or excessive noise easement."[35] The easement becomes then a property right. Consequently the level of certainty for the first user increases, which reduces overall uncertainty in an economy and therefore leads to higher efficiency (Cordato 2004).

Conclusion

The essay has shown the fundamental differences between the Neo-classical and the Austrian School of Economics. Neo-classicals believe that free markets do not take account of pollution costs, which leads to inefficiency and therefore markets are doomed to fail. Here governments have to intervene and correct market failure, either with taxes or with tradable permits. Further, it was shown how

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[32] Rothbard, M. (1982) *Law, Property Rights, and Air Pollution*. USA: The Cato Journal (vol. 2, no. 1)

[33] For example, in terms of the USA air pollution was reduced long before any federal regulations were adopted (most importantly the Clean Air Act of 1970). From 1950 to 1970, the amount of volatile organic compounds and carbon monoxide in the nation's air fell by more than 20%, (while total vehicle-miles travelled rose by 120%). The level of sulphur dioxide in the air began falling from 1920 on, and the total amount of airborne particulate matter has been reduced by 79% since 1940. Yet 30 years of regulating, the EPA is unable to produce evidence that its efforts have independently improved air quality [Weinert, P. (1998) *Hot Air*. USA: Mises Institute, The Free Market (Vol. 16, No. 9)].

[34] Hoppe, H.H. (2004) *The Ethics and Economics of Private Property*. USA: Mises Daily Article

[35] Rothbard, M. (1982) *Law, Property Rights, and Air Pollution*. USA: The Cato Journal (vol. 2, no. 1)

governments could remove market failures with the help of these instruments. While taxes tackle the pollution problem at its source and give strong incentives to innovate, tradable permits are a decentralised, market-based concept, which can also be exerted internationally. Most commentators argue here for a hybrid mixture of taxes and permits, which could be more efficient than only one instrument[36]. In contrast to that, for Austrians government interventions are inconsistent with free markets and environmental problems are not due to market but to government failures since "government (…) has failed grievously to exercise its defence function"[37]. Ultimately, pollution is due to interpersonal conflicts, which neither taxes (central planning) nor tradable permits (violation of property rights) can resolve. Because of this, Austrians offer three solutions: Privatisation and the 'first come first served' principle to define property rights and the 'polluter pays' principle in order to enforce them. For sure, no theory is without controversy but it is fairly save to conclude that environmental problems could be solved by market forces and do not need government intervention since only markets effectively resolve interpersonal conflicts, something governments failed to achieve for centuries.

[36] Pezzey, J. (2003) *Emission Taxes and Tradable Permits: A Comparison of Views on Long-Run Efficiency*. Netherlands: Environmental and Resource Economics. Kluwer Academic Publishers. p 329
[37] Rothbard, M. (1973) *For a New Liberty*. Great Britain: Collier Macmillan Publishers, London.

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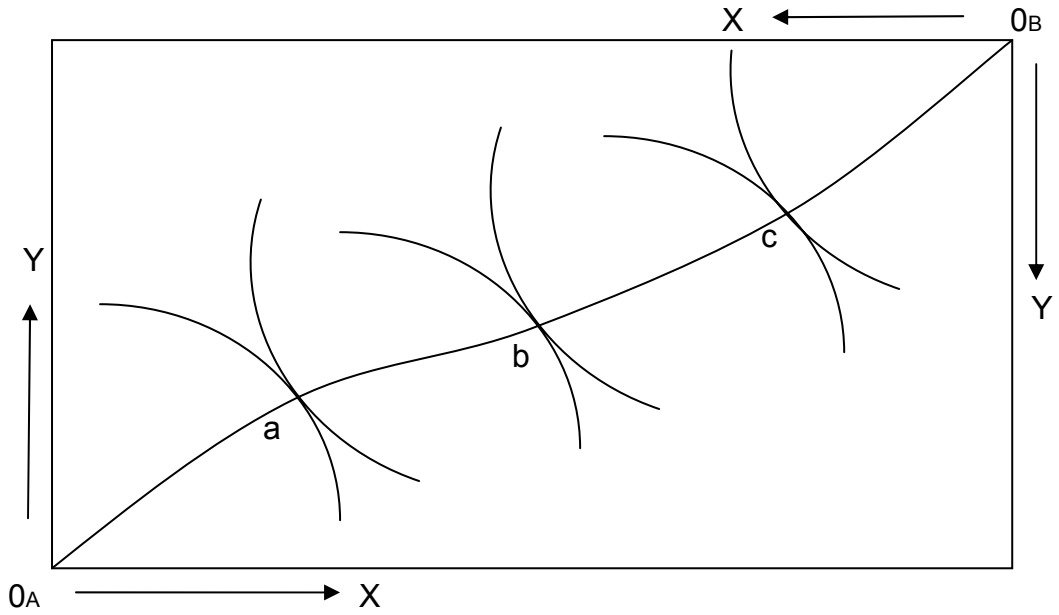
Appendix 1

Economic Efficiency

There is economic efficiency when distribution and production efficiency are achieved at the same time. Distribution efficiency is reached when further exchange between individuals cannot make one person better off without harming others. Thus, no mutual gain from exchange can be made. Technically the ratios of marginal utilities (MU) are the same for both individuals: $(MUx/MUy)_A = (MUx/MUy)_B$ The slope of the indifference curve is $-dy/dx = Ux/Uy = MRSyx$ and since marginal utilities of both individuals are equal their indifference curves must have a common tangent: $(Ux/Uy)_A = (Ux/Uy)_B$. An Edgeworth box[38] visualises this condition.

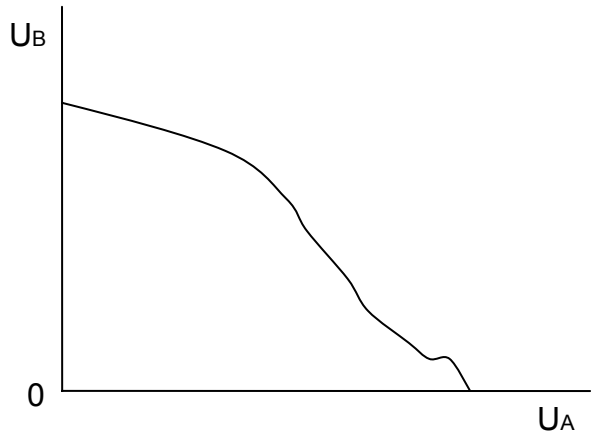
Graph 6 shows different indifferent curves of individual A and B. Each point individual A's indifferent curve is tangent to B's (a, b and c) is a Pareto efficient allocation. All these points lie on the efficiency locus or contact curve.



Graph 6: Distribution Efficiency illustrated via an Edgeworth box

When we plot all points from the efficiency locus we receive UPF (Utility Possibility Frontier, Graph 7).

[38] Edgeworth box is a 2x2 model in general equilibrium where two goods and two individuals are assumed. The whole amount of goods is represented by the box.



Graph 7: Deriving the UPF from production efficiency

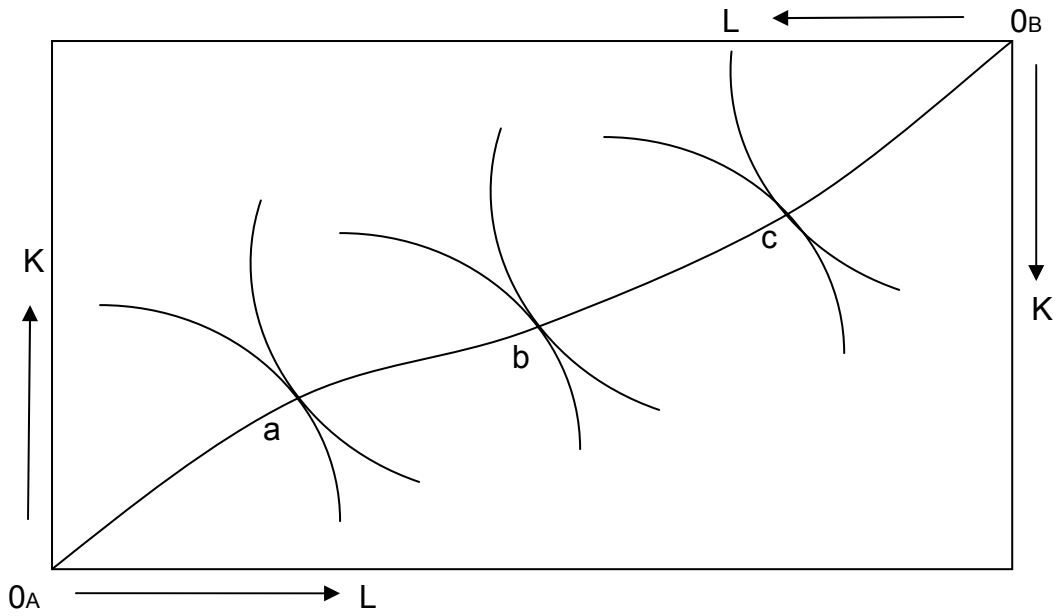
The second condition for economic efficiency is production efficiency and must be met to avoid waste of resources and achieve technical efficiency. When it is achieved it is impossible, by reallocating factor inputs, to expand the output of one good or service without other good's output falling. Again, by assuming two individuals (A and B) and two products (Labour and Capital) marginal productivity (Marginal rate of Substitution) of the two factors must be the same:

$(MRTS_{L}/MRTS_{K})x = (MRTS_{L}/MRTS_{K})y$

Here the factor inputs are equally productive in all uses to which they can be put, therefore:

$(MRTS_{LK})x = (MRTS_{LK})y$

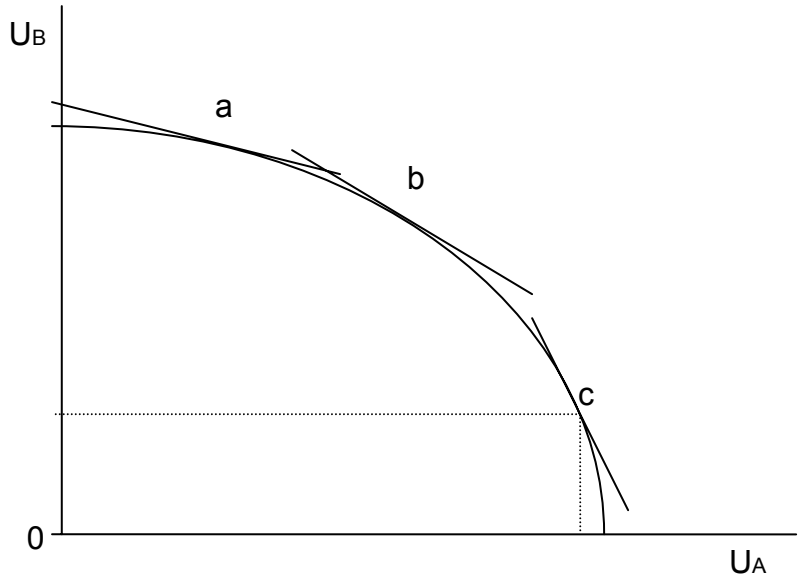
To visualize this condition we use the concept of an Edgeworth box (Graph 8) again, however in this case not with indifference curves but with isoquants[39], since we are on the production side.



Graph 8: Production Efficiency illustrated via an Edgeworth box

[39] Isoquant: Trade-off between two goods

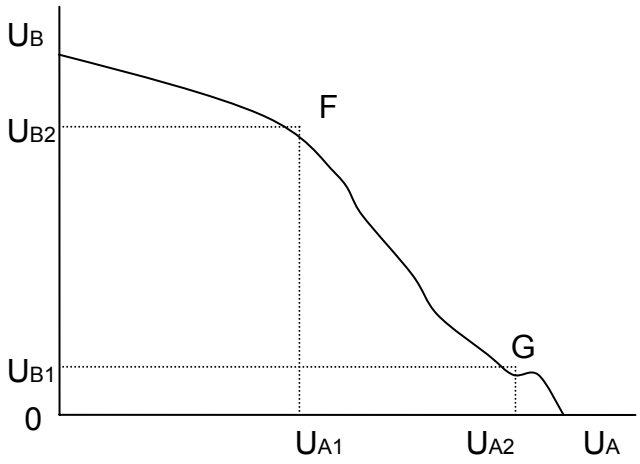
When isoquants are tangential to each other (a, b and c) we receive production efficiency according to the previous stated definition. When we plot all possible combinations of the efficiency curve, we receive the Production Possibility Frontier (PPF), as shown in Graph 9.



Graph 9: Deriving the PPF from production efficiency

If production and distribution efficiency is reached simultaneously we get economic efficiency, which is the condition concerned with determining what the given bundle of goods and services should be. Under this condition, no change in the goods total or its distribution can make one person better off without harming another. Visually it means selecting the 'best' point on the PPF plus the one, which satisfies distributive efficiency. This means that the rate at which individuals in society are willing to substitute one good for another (= MRS) is equal to the rate at which society is able to transform one good into another (=MRT). Therefore: $(MRSxy)_A = (MRSxy)_B = (MRTxy)$FOR SOCIETY

Putting all together, we can derive the Grand UPF



Graph 10: The grand UPF

Looking at Graph 10, all points on the grand UPF are Pareto efficient. Here the question arises how we can chose between two points, e.g. F and G since both are efficient but have a different distribution of income and wealth. In this case, Welfare Economics provides us with two theorems, the Efficiency and the Equity theorem.

The Efficiency theorem argues that, as long as P=MC (perfect competition) markets are superior and automatically take a position on the UPF in terms of economic efficiency. In contrast to that the Equity theorem states that it is possible to get any efficient point on the UPF by redistribution of income and wealth. However, this intervention (done by the government) is highly subjective because, as soon as the market's decision is not taken as given anymore, the question arises which the right distribution of wealth and income is.

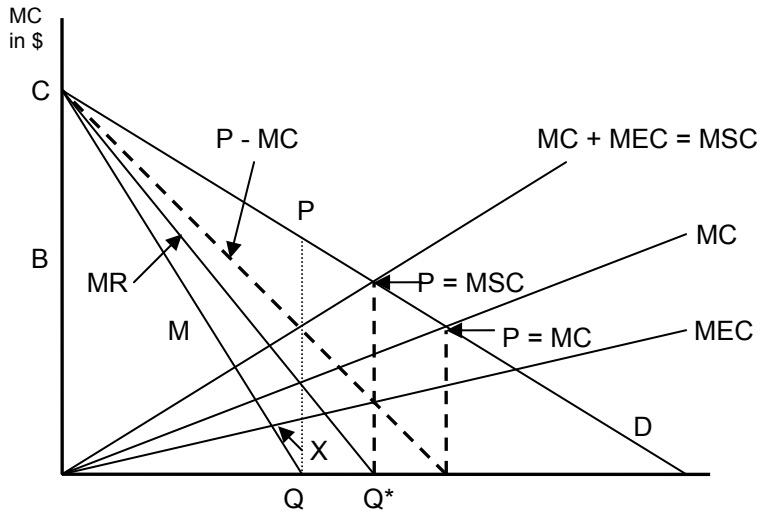
One suggestion to solve this problem is the Kaldor-Hicks Compensation test (1939), which ought to be "a reaction to the Paretian nihilism that it is impossible to say anything scientific or positive about an economic change if it makes some people worse off at the same time as it makes others better off because individual utilities cannot be compared."[40] Basically the test says that if government reallocates income and wealth from F to G (F was automatically chosen by the market [Efficiency theorem] but G is also Pareto efficient [Equity theorem]) then there is a gain in welfare from UA1 to UA2 and a welfare loss from UB2 to UB1. If gainers can overcompensate losers in monetary terms then there is a Pareto improvement. The Scitovsky's reversal test (1941) studies under what conditions the result was achieved by looking backwards, i.e. from G to F. Through applying indifference curves to the grand UPF it can be seen in which point a higher indifference curve can be reached. This point where the indifference curves tangent the grand UPF is called Optimo Optimoto.

[40] A.P. Thirlwall. Charles Kennedy 1923-1997: An Appreciation (1998)

Appendix 2

Coase Theorem under imperfect competition

Graph 11[41] demonstrates an imperfectly competitive firm maximising profits. Q is the bargaining output if marginal profit is the bargaining curve and the bargaining outcome if the curve P – MC is the polluter's bargaining curve. Although P – MC = MEC secures an optimum it is not equal to marginal profit. Therefore P – MC is a 'marginal surplus' curve, which is the marginal change in combined producer and consumer surplus (Pearce and Turner 1990). The optimal outcome occurs when the 'marginal surplus' curve is set equal to MEC and the two curves are bargaining curves. According to Buchanan (1969), the implication is that bargain has to take place between the polluter, the consumer of polluter's product and the suffers. Ever since this restores the Coase Theorem, it is difficult to foreknow that such a bargaining is taking place.



Graph 11: Coasian bargains and imperfect competition

[41] Source: Pearce and Turner (1990)