

THE WELFARE COSTS OF NOT BEING PART OF THE KNOWLEDGE ECONOMY: WHY RURAL DEVELOPMENT NEEDS MORE CREATIVE POLICY STRATEGIES

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Abstract

All forms of knowledge, from advanced science to the simple idea of finding a new use for an old good, contribute to economic growth, not by competing for scarce resources in existing markets but by creating new markets. Current agricultural, environmental and development policies ignore the social welfare generated by new markets because they are still based on the comparative-static approach of neoclassical Welfare Economics that only looks at the welfare effects of existing markets. This approach may have offered practical solutions in the Cold War context but looks increasingly outdated in today's dynamic knowledge-based economy. New Growth Theory, the more dynamic successor of neoclassical Welfare Economics, puts knowledge creation at the centre of economic analysis. It suggests that improved access to new knowledge and technology, investment in human capital and effective support of rural entrepreneurship will result in a more responsible use of natural resources as well as more choice, diversity, social empowerment and economic growth in poor rural areas. This article discusses the major insights of New Growth Theory, its successful policy applications, as well as the reasons why policy decision-makers in charge of rural development tend to stick to old theory and therefore merely see themselves as regulators rather than facilitators of economic change.

1. Introduction

Wealthy urban dwellers from the baby-boom generation continue to shape the cultural, academic and political life of early 21st century. They tend to have a rather pessimistic view of globalization even though they turned out to be the great beneficiaries of this unprecedented phase of economic prosperity and social welfare after World War II. Still influenced by the report 'The Limits to Growth' published in 1972 by the Club of Rome, they argue that the global market economy is unsustainable because it would grow at the expense of the rural poor and the environment.

Current agricultural, environmental and development policies are largely reflecting the popular desire to promote sustainable development by preserving and protecting rural communities and their environment from the forces of globalization. Such policies find their theoretical legitimacy in the 'social welfare function'¹, a concept developed in applied Welfare Economics (a branch of neoclassical economics) that is supposed to reflect the aggregated normative preferences in a certain society. Such aggregated preferences are also assumed to reflect the social and environmental values of the respective society. Applied Welfare Economics implies that there is market failure in the sense that the market economy would not address these normative preferences and therefore produce negative externalities for society at large.

In this context, the government is expected to assume the role of a rational all-knowing social planner that aims to achieve the normatively set goals (with respect to the aggregated preferences) through the design of effective public policy strategies. Apart from the fact that such policy strategies primarily reflect the public perception of the affluent non-rural population rather than the real challenges the rural poor face on the ground, there are several flaws associated with the underlying theoretical concept of applied Welfare Economics:

1. Neoclassical Economics, which provides the theoretical underpinning of today's social welfare policies, is still exclusively based on the laws of diminishing marginal utility and decreasing returns. These laws assume that no new goods will come into being whereas the returns from the production of existing goods as well as the utility derived from their consumption will diminish over time. Such pessimistic assumptions imply that the market economy would eventually come to a standstill. Yet, in reality we observe the opposite: the market economy generated more economic growth and social welfare over the past century than a centrally planned economy could ever have dreamed of – and it continues to do so [3] [4].

2. The goal of applied Welfare Economics is to maximize welfare through the optimal allocation of scarce resources (Pareto criteria) and the adequate compensation of the identified losers (Kaldor-Hicks criteria). These two criteria are used to implement the normative policy objectives, set by the 'social welfare function'. Yet, there is no such thing as a social welfare function because individual preferences and the individual utility functions (on which the estimated normative aggregated preferences are based on) are socially constructed, manipulable, unstable and highly diverse [5]. It is, however, a very convenient function for opportunistic political actors who try to gain the public's favour by claiming to act in the 'public interest' (supposedly reflected the contrived aggregated normative preferences).
3. The concept of the rational social planner is associated with the successful implementation of the normative goals set by the social welfare function. The concept was crucial to the centrally planned socialist economy and continues to be widely applied in agricultural, environmental and development economics. The failure of communism suggests however that such a naïve view of government as a responsible and responsive social planner often results in large-scale mismanagement of public resources rather than social welfare [6].
4. Applied Welfare Economics claims to be the best theoretical concept to manage public goods, which are assumed to be based on non-rivalry (they can be used by many without loss in value) and non-excludability (no one can be excluded from using them). However, apart from clean air, there is probably no other pure public good on this planet because the public goods that are provided by the state are primarily meant to serve its tax-paying citizens only (outsiders can be excluded). In this national public good concept, the private sector is defined as a producer of negative externalities (e.g. a company pollutes the environment and society at large has to pay the cost) and as unable or unwilling to provide public goods ('market failure'). Yet, the private sector is also producing positive externalities (e.g. more choice, employment, technological innovation, wealth and a more efficient use of natural resources) and technological evolution makes it increasingly efficient to let the private sector help manage public goods. The concept therefore ignores the fact that positive and negative externalities are general by-products of any human action no matter whether they originate from public or private sector action [7].

These inadequate assumptions of neoclassical Welfare Economics were identified and rebutted by many of the leading economists of the past five decades representing different types of economic analysis (e.g. Romer [8], Olson [9], Kahneman and Tversky [10], Buchanan and Tullock [11]). Yet, apparently their insights only had a minimal impact on mainstream textbook economics as David Warsh illustrates in his recent bestseller 'Knowledge and the Wealth of Nations' [12].

The persistent popularity of applied Welfare Economics in education and public policy brings us back to the wealthy baby-boomers and their continuing influence in academia, government, and mass media.

As young idealistic students, the baby-boomers protested in the 1960s and 70s against the capitalist mindset that would result in the exploitation of the poor and the destruction of the environment. Their protests led to many welcome responses in business and politics but their enthusiasm for Freud, Rousseau and Marx was happily ignored by the policy decision-makers at that time. Today, the aging baby-boomers have become more moderate but are still fond of these controversial thinkers. They believe that economic globalization is a zero-sum game (one society grows rich at the expense of another) and would cause social, environmental and psychological damage that must be addressed by the government in its role as the wise social planner. The idea of the social planner is equally prominent in Marxist and Welfare Economics and therefore helped the former disciples of Marxism² to re-invent themselves as responsible political leaders that embrace a socially acceptable form of market economy. The same applies to the more romantic followers of Rousseau and his idea of a social contract. The social welfare function is well-placed to be interpreted as a sort of *volonté générale* (general will of the people) that needs to be respected in the social contract.

There is increasing evidence that this ideologically stretched version of Welfare Economics may create more problems than it is solving in the area of rural development and environmental management³. Even though Welfare Economics might well have been the best theoretical concept available to address the challenges posed by the Cold War (state interventions in the name of national security made perfect sense), it may turn out to be counterproductive in today's global knowledge-based economy. Especially in view of the availability of a more advanced economic theory that promises to be more practical, fair and sustainable.

This more advanced economic theory is called New Growth Theory, the economic theory of the new knowl-

edge economy. New Growth Theory rejects the idea of a social planner and sees opportunities where Welfare Economics just sees problems. Paul Romer, who is widely considered to be the father of this new theory, argues that knowledge applied in the process of innovation is a non-rival good that is not limited by the laws of scarcity. Investment in knowledge therefore generates increasing returns through the creation of new markets. This simple insight explains why the market economy continues to grow in spite of decreasing returns in existing markets [13]. New Growth Theory is not just a substitute for Welfare Economics but adds a dynamic dimension to it that highlights the social welfare surplus resulting from the introduction of new goods and services (positive externalities). In this concept, it is monopolistic competition and not perfect competition that generates innovation and new markets. This type of competition is not primarily based on cutting prices of existing products but on augmenting product characteristics (variety, quality, features) and the introduction of new products, processes and services. The basic insight of the theory is that knowledge is a non-rival good that may be costly to produce but once produced, can be infinitely re-used at zero marginal costs.

As a result, the increasing growth of knowledge increases the probability that new goods and services are generated through the commercial use of this knowledge. Knowledge therefore creates opportunities for nearly boundless growth, not by devouring more scarce resources (labour, land) but by developing new ways (e.g. instructions, designs) how to make more efficient and creative use of existing resources. In other words, 'the raw materials that we use have not changed, but as a result of trial and error, experimentation, refinement, and scientific investigation, the instructions that we follow for combining raw materials have become vastly more sophisticated' [8].

Since the concept of scarcity does not apply to knowledge, knowledge also holds the keys to a more sustainable future that facilitates social empowerment through improved access to knowledge and entrepreneurship and makes economic growth more compatible with environmental sustainability. Yet, for that to happen, policy-decision makers should not rely on a wise social planner but create the institutional environment and the human capital that ensures equitable access and effective use of knowledge. In other words, governments need to become aware that they are not just regulators but also facilitators of economic development.

The first part of this article aims at making the reader more familiar with New Growth Theory and its relation to trade and development. It will be focused on Paul Romer's argument that the welfare losses of trade restric-

tions are not so much related to deadweight losses for consumers but the fact that they prevent new (knowledge-based) goods from being introduced into the national economy. The second part of the article focuses on the issue of agriculture and rural development. It shows, how the principles of Welfare Economics were applied during the Cold War (e.g. Green Revolution in developing countries and the centrally planned agricultural policies in developed countries) and how they continue to be applied after the Cold War in the form of cross compliance schemes for developing countries (compliance with food and environmental standards in return for foreign aid and access to export markets) and developed countries (complying with agro-environmental measures in return for more direct income support). The main argument is that the Post-Cold War policies are likely to harm rural development more because they involve more cultural paternalism and discard any possibility that modern technology could benefit the countryside in general and the poor in particular. Finally, the article advocates a change in rural development policies by skipping the old approach of neoclassical economics in favour of the more dynamic New Growth Theory and the Theory of Incentives [14]⁴.

Development, environmental and agricultural policies that are derived from New Growth Theory set the priority on the 'freedom to innovate' and reflect a return to the 19th century model of the land grant college system, that was designed to support farmers and the rural economy not through subsidies but through the transfer of useful knowledge that helped to solve practical problems, promoted technological innovation and generated local business. The spirit of this 19th century approach is being rediscovered today in developed and developing countries and its results prove to be compatible with rural empowerment and sustainable development alike. The case of New Zealand's agricultural policy and the successful international agricultural research initiatives undertaken by the global Cassava Biotechnology Network (CBN) will be used to illustrate the case.

2. New Growth Theory and the true value of technological change

Most economists today are still trained in neoclassical Welfare Economics. The neoclassical approach is mainly focused on the allocative efficiency in the production of an existing set of goods. Its basic comparative-static assumptions of perfect competition, knowl-

Monopolistic competition: A market structure in which several or many sellers each produce similar, but slightly differentiated products. The demand for each good is not perfectly elastic. Each firm command brand loyalty and can set its price and quantity without affecting the marketplace as a whole.

edge as a pure public good, and price-setting as market failure were very popular in the 20th century because they enabled elegant mathematical formalizations of general and partial equilibrium models from the household economy to the world economy. This neoclassical approach is based on the assumption that all goods and technologies that could possibly exist, do already exist.

This philosophy of plentitude [16] proves to be particularly inadequate in a knowledge economy where the exponential growth of knowledge leads to an exponential growth of the probability that new goods and technologies come into being and generate new markets. This process is not just the primary source of wealth and prosperity but also generates a social welfare surplus that cannot be captured by the innovating company itself. Paul Romer, the father of New Growth Theory, used the formal language of neoclassical economics but put endogenous technological change at the heart of economic analysis [8]. This more dynamic version of welfare economics was able to formally prove the social welfare effect of new goods [4] while disqualifying the very basic convexity assumptions of the neoclassical model [13]⁵.

2.1 Explaining the knowledge economy

New Growth Theory emerged in the 1990s in response to the inadequate assumptions of neoclassical theory. In his paper 'Endogenous Technological Change', Paul Romer [8] showed that knowledge, unlike other production factors such as land, labour and capital, is a non-rival good that can be used by many simultaneously without losing in value. Thanks to the revolution in information technology this knowledge can be reproduced at almost no additional costs. Yet, the creation of new knowledge itself is expensive since it requires large fixed costs spent on research and development (R&D). These costs also include the hiring of scarce and expensive human capital, the most sought-after resource in the knowledge economy [17]. It is therefore not surprising, that those who create new knowledge want to make its use partially excludable through intellectual property rights (IPRs). This temporary monopoly right allows the owner to extract a rent by putting the price of the new knowledge-intensive product above its marginal production costs. It thus enables his or her company to generate a profit that compensates for the high fixed costs spent on R&D, and provides incentives to invest again in the improvement of the product and the development of new products.

Neoclassical economists (and this includes neoliberal as well as welfare economists) often denounce this kind of monopolistic competition as the extraction of an underserved rent by a monopolist at the expense of the consumers that suffer deadweight losses due to the higher price they have to pay for the product. This thinking is however based on two contested assumptions that (a) knowledge is a pure non-excludable public good funded by governments and produced at public universities and national research institutes and that (b) monopolies are the result of underserved market power achieved through rent-seeking (e.g. regulation that protects the incumbent from new competitors).

These two assumptions are not wrong but they are not the whole truth. Governments indeed fund the production of knowledge and make sure that it is widely accessible. But the private sector also invests in a more specialised kind of knowledge production that enables it to successfully convert the widely accessible knowledge into new goods, technologies and services. Moreover, the monopoly profits that result from the introduction of new goods into the economy are different from monopoly rents extracted by incumbents that raise barriers to entry for new innovative players. The former are based on and encourage further innovation while the latter is based on political market power and prevents innovation through regulatory capture.

The introduction of new goods through innovation generates a social welfare surplus that cannot be captured by the company itself (e.g. more employment, more tax revenues, more knowledge in the public realm through patent disclosure, economic spillovers, that lead to generic products that are also affordable to poorer consumers/producers, etc). Knowledge is therefore not just benefiting the company that invests in it, but generates cumulative and catalytic effects that benefits society at large: the bigger the stock of knowledge available the higher the likelihood that new goods emerge. These new goods are based on ideas that successfully combine existing publicly available knowledge with new proprietary knowledge. They may create temporary monopolies that generate increasing returns but, in the long run, there will be more competition and the new goods will eventually become commodities, or bulk products, with decreasing returns (price becomes the dominant criteria of competitiveness).

Ideas are therefore at the root of economic and social change and the primary engine of economic growth. However, ideas are always embedded in a good like a machine or a service, and because they are intangible, we do not think of them as separate entities [4]. Information technology and biotechnology may have changed our awareness of

the difference between ideas and products. New software programs (based on the use of the digital code) and new proteins with certain useful qualities (based on the use of the genetic code) are close to pure ideas. As more and more ideas accumulate and enter the public realm, more knowledge is available about how the world works and how to extract greater use out of the finite set of resources with which the world is endowed [13]. In this context, the separation of basic and applied research becomes increasingly difficult because the development of new technologies and the wide application of existing technologies generate new knowledge that will again influence discoveries and theories in basic research.

2.2 The social welfare generated by new goods

The social welfare that results from the introduction of a new good is not new but was already noticed by a French engineer called Dupuit in the 19th [18] [4]. He calculated the cost of building a bridge and the minimal toll the users of the bridge need to pay to reimburse the fix costs for building the bridge. He was able to show that the entrepreneur who builds the bridge is constrained in his efforts to extract a maximal rent from the users, because if the toll is too high, the user might simply not use the bridge (assuming that the users are acting in a competitive world with scarce resources themselves). He therefore concluded that the entrepreneur can never capture all the benefits of building the new good ‘bridge’. The bridge would therefore generate a social welfare surplus by the mere fact that it lowers

general transportation costs and facilitates more trade and exchange among people in the region. The same is true for a company that wants to develop a new technology. Yet, instead of extracting an additional rent through a toll price (as in the case of a physical good), the company would do it through a royalty fee on the patented technology.

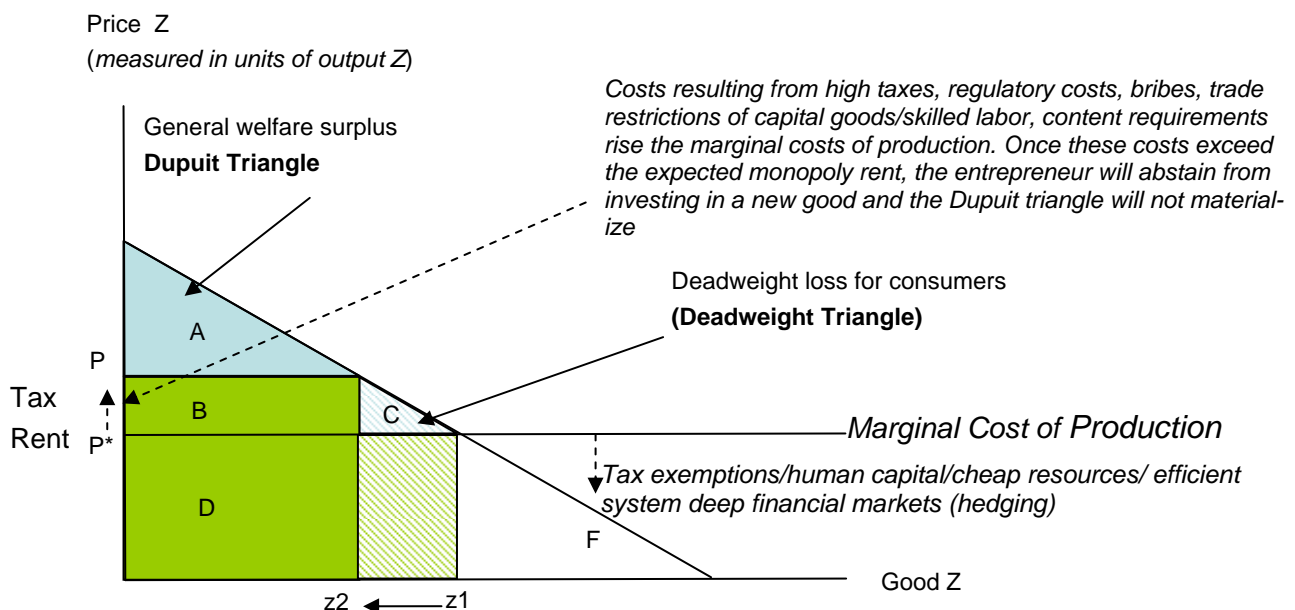
2.2.1 Making welfare economics more dynamic

The creation of new goods that emerge from monopolistic competition can be illustrated by making use of a simplified version of an economic model that was adopted from Romer 1994 [4] (see Figure 1). It represents a partial equilibrium model with the x-axis referring to the amount of production of Good Z and the y-axis its price per unit charged by the company.

The price per unit is higher than the marginal production cost because the company aims at reimbursing the high fixed costs spent on the development of Good Z (not represented in the marginal cost of production)⁶ and making profits that allow for further investment in R&D.

Neoclassical economists interpret this graph as a typical case of a market that is dominated by a monopolist: there is only one producer of Good Z, which has the power to determine the scale of production and set the product price in a way that maximizes the expected returns (the sloping demand curve illustrates how the price increases with decreasing output). In order to illustrate the monopolist rent, the neoclassical economist would point at rectangle B, which represents the surplus the

Figure 1: The social welfare generated through the introduction of new goods (graph adopted from Paul Romer [4])



monopolist extracts through market power, and also triangle C representing the deadweight loss for consumers who have to pay a higher price for the good. However, if this monopolist has obtained his position not through rent-seeking but the investment in the development of a new good, then the graph must be interpreted in a different way. In this case the curtailing of the production of Good Z is not related to a rent-seeking strategy (creating artificial scarcity that pushes up the price of Good Z), but represents the resources that were diverted from the production of Good Z and invested in the development and production of a new Good X. The subsequent introduction of the new good is then creating an additional Triangle A which represents all the positive externalities associated with a new good. This social welfare triangle has been ignored by economists prior to Romer.

Romer concludes that if economists would become aware of this Triangle A, which he also calls Dupuit triangle, they would realize that the primary source of wealth and well-being in society is not based on perfect competition but the introduction of new goods and technologies through monopolistic competition. New technologies may create new inequalities and risks at the beginning, when only few have access to the relatively expensive technological innovation, and accidents may happen due to lack of experience with the new technology. But in the long run, many new competitors enter the market (if effective anti-trust laws are in place), increase the total offer and the choice through different versions of the new good, constantly improve the safety and lower the price. Eventually, the product becomes cheaper and safer and turns into a commodity designed for a global mass market. At this stage, the broad access also makes it a potential tool of empowerment; people start to adapt and tailor the new technology to their particular needs by combining their local knowledge with the new knowledge.

2.3 Governments as regulators and facilitators in developing countries

The creation of knowledge is however not a pure product of market forces and not all knowledge that is produced in the private sector increases social welfare. Almost every technological revolution has its roots in public sector-sponsored R&D [19] [20]. Moreover, the kinds of knowledge that are created in the private sector as well as the use and access to this knowledge are often influenced by government institutions [13].

Welfare economics gives the impression that governments are needed only when markets do not result in

socially desirable outcomes (e.g. market failure, the provision of public goods). The role of governments is therefore believed to be limited to the regulation of the private sector and the production of public goods. New Growth Theory challenges this view of the public sector. Firstly, the theory argues that public goods can and are increasingly provided by the private sector because a more market-friendly institutional environment and advances in technology⁷ create the right incentives to do so; and, secondly, government policies are not just designed to regulate the private sector but to facilitate economic growth. In this concept market failure exists primarily because markets fail to invest sufficiently in knowledge and human capital due to the lack of economic incentives [13].

2.3.1 Losing the Dupuit Welfare Triangles in Developing Countries

In developing countries, governments often lack the means to invest sufficiently in tacit (human capital) and codified knowledge (technical instructions, publications), the two essential ingredients for the local private sector to develop and produce new knowledge-based goods. The production of new goods would be especially important in these countries because they still largely rely on the production and trade of primary commodities with decreasing returns. They could offset the decreasing returns from existing goods with increasing returns from new goods and thus facilitate the transition toward a knowledge-based economy. Since they are not in a position to generate sufficient tacit and codified knowledge themselves, developing countries are more dependent on its import through open-access agreements, research partnerships and foreign direct investment. Often foreign companies would prefer to simply export their goods but not the knowledge required to produce the good. Policy makers in developing countries must therefore create adequate incentives that induce foreign companies not just to sell the new goods but also produce them in their country. Such investments eventually increase the stock of knowledge and human capital in the developing country.

Yet, national governments in developing countries often tend to discourage such private sector investment by imposing high profit taxes, trade restrictions on essential capital goods, prohibitively high safety regulation, and inefficient and burdensome government bureaucracies. Corruption and weak protection of intellectual property rights can additionally increase the costs up to the point where a company decides not to invest anymore (despite cheap labour and abundant natural resources) because

the costs exceed the expected gains. So the new good will simply not be produced and this means that the respective country loses the social welfare benefits of the Dupuit triangle [4].

Instead of just taxing and regulating companies and pushing up the bar of their costs of production, governments can also serve as facilitators and encourage investment through tax exemptions for R&D, a high degree of political stability, a valuable stock of domestic human capital (through more responsive universities), dependable public infrastructure as well as a relatively open and developed financial market (allowing for a better hedging of risks).

2.3.2 Why export of regulation from rich to poor countries is harmful

Governments in rich developed countries have the means and the institutions to become attractive facilitators of private sector investment and, they can afford to increase regulation (e.g. high environmental and food safety standards, labour rights, high corporate taxes etc) without discouraging private sector investments. The facilitating institutions (tax credits for R&D, good infrastructure, large stock of codified and tacit knowledge) plus the strong purchasing power and the large market size make it profitable for a company to invest despite the high regulatory costs. Poor countries, however, are in a different position: because the state budget is too small to improve investment conditions and the market is tiny, additional regulation may quickly erase the profits that foreign companies expect to make, and therefore investment does not happen. This again leads to the loss of the Dupuit triangles.

Ironically, the increasing regulatory costs in developing countries that prevent the introduction of useful knowledge into the local economy are imposed by Western government and NGOs. They often require poor developing countries to adopt costly and unpractical regulatory frameworks in return for access to their affluent consumer markets and generous foreign aid. These Western 'experts' tend to be convinced that they protect the interests of the poor and the environment through such exports of regulation when in reality they may perpetuate poverty and the unsustainable use of natural resources. Their thinking makes sense in the concept of Welfare Economics, but becomes nonsense in the concept of New Growth Theory (because it is merely focused on the production and dissemination of existing goods and ignores the introduction of new goods).

3. How to use knowledge and technology for development?

As illustrated above, the primary contribution of companies to social welfare may not occur through general taxes (as widely assumed) but through the generation of new goods and services. Yet, the problem is how to get the private sector to invest in the production and commercialization of goods that would result in large social and environmental welfare surpluses⁸ and contribute to national security issues (e.g. food self-sufficiency).

These goods would produce huge Dupuit welfare triangles but often the low purchasing power, the small market size and the high regulatory uncertainty associated with the introduction of a new good are lowering the chances of sufficient profits to compensate for the high fixed costs. And if a company would develop such a good, despite all the uncertainty and the low expected revenues, it would be very difficult to enforce partial excludability (people would argue that the product has public good character and therefore should be available free of charge).

The question therefore is whether it should be the public sector that develops and produces these goods or whether there is any possibility to induce the private sector to participate in the production of these goods.

During the Cold War, neoclassical welfare economists provided the tools and the justification for the public sector to be exclusively in charge of the production of such goods. The Green Revolution was an international public sector initiative to develop, produce and disseminate new hybrid varieties of major staple food crops with the objective to avert hunger and starvation in non-aligned developing countries. At the same time, production subsidies and market protection for domestic agriculture were introduced in developed countries (in order to ensure food self-sufficiency), and state enterprises were fully in charge of network industries in order to ensure the countrywide coverage of essential communication, transportation and energy services in case of war.

The following chapter will illustrate the theoretical background behind these policies and explain why such policies still prevail in the post-Cold War period, especially in the area of agricultural, environmental and development policy.

3.1 Development Policy in the Cold War Era:

Public Policy during the Cold War era was highly influenced by the main principles of neoclassical Welfare Economics largely developed by three noble laureates in economics: Paul Samuelson, Kenneth Arrow and Robert Solow.

Samuleson [21] argued that public goods must be provided by the state because the private sector fails to do. He illustrated this with the lighthouse example: a lighthouse would potentially benefit all shippers but no shipper actually has an incentive to finance it because the others could equally benefit (free-rider problem). Since everyone benefits from a lighthouse and no one should be excluded from its use, Samuelson believed it to be a public good that must be provided by the public sector. Ronald Coase showed that this argument does not correspond to historical facts: lighthouses financed by user fees paid by shippers existed in Europe already in the 18th as he pointed out in his publication in 1979 [22].

Kenneth Arrow [2] believed that democratic decision-making results in rational social choice and is therefore best able address economic and social problems. In his conception, rational social choice ensures the pareto-optimal allocation of scarce public resources (making at least someone better off without putting anyone worse off). Since everyone is assumed to agree to such a choice, the respective political decisions are assumed to be based on unanimity and thus do not result in any externalities. Buchanan and Tullock [11] questioned these assumptions by highlighting the fact that the democratic decision-making process is neither based on unanimous decisions nor does it necessarily produce optimal outcomes from a social welfare point of view. Political actors pursue their self-interest and are not driven by the desire to maximize social welfare. Yet they might inadvertently produce social welfare because they have different intensities of preferences which they are willing to trade (through side-payments in a successive game of political decision-making).

Finally, Robert Solow [23] developed a model that was still based on the neoclassical assumption of diminishing returns, but added a third factor, technical knowledge, that would keep economic growth from slowing down. With this model he managed to reconcile economic growth with the principle of neoclassical Welfare Economics. The model treats technological change as an exogenous factor merely leading to a shift of the aggregate supply curve. It can therefore be perfectly integrated into the neoclassical model of perfect competi-

tion where companies are portrayed as passive price-takers. In this concept, knowledge is treated as a public good that must be funded by the public sector (assuming that it is based non-rivalry and non-excludability). Paul Romer was able challenge Solow's growth model with his paper on endogenous technological change [8]. In this paper he showed that technology as an input is neither a conventional good nor a public good but a non-rival, partially excludable good. In his theoretical model it is neither the public sector nor perfect competition but monopolistic competition that generates new goods and services.

3.2 The mindset of agricultural economists and how it influenced agricultural policy and the Green Revolution

In spite of these inconsistencies, policy makers continued to design public policies in accordance with the principles of neoclassical economics. These principles were however not just used to justify neoliberal supply-side economics that favour small government and a *laissez-faire* market economy but also demand-side economics that advocates government intervention whenever someone claimed to see market failure.

Agricultural and development economists are specialised in the management of presumed market failure and the production of public goods. While they argued that the high adoption rates of technology in agriculture in industrialised countries would produce negative externalities for the farmers themselves (production surpluses, low prices) they were also concerned about the absence of agricultural technology in developing countries (which could lead to hunger and starvation because of low productivity in agriculture).

To explain the problem of overproduction in industrialised countries, agricultural economists used the concept of the so-called agricultural treadmill [24]. In this concept, farmers are passive price-takers in a market of perfect competition in which they produce a homogenous⁹ and inferior commodity. The role of technology is reduced to its potential to increase agricultural productivity (while its potential to improve food quality is not addressed). Since farmers are standing in perfect competition, they are assumed to produce at the level where their marginal costs just equal their marginal revenues. It is possible that certain farmers adopt a new technology that allows them to lower their production costs and produce more efficiently. This gives them a temporal advantage and thus a windfall profit. Yet, this advantage is quickly erased because all the competitors will have to follow suit if they want to stay in business. This agricultural treadmill, so it was argued,

would then inevitably result in a surplus of food production and the continuing decrease in relative food prices.

Unsurprisingly, agricultural economists concluded that this treadmill of technological innovation tends to benefit food consumers and input providers at the expense of food producers. They argued that the agricultural treadmill is producing a sort of market failure since farmers would get poorer even though they produce more, due to the inferior prices. By invoking these negative externalities and the need to ensure 'national food self-sufficiency' in view of the potential threat of the Cold War, they argued in favour of government intervention designed to support domestic farm production and avoid dependence on food imports. This resulted in highly complex agricultural policies that increasingly produced negative externalities themselves (export subsidies to get rid of production surpluses, environmental degradation, monoculture practices etc).

In retrospect, even agricultural economists would admit that it was probably not the agricultural treadmill, but the market-distorting instruments of agricultural policies that provided the biggest incentives to adopt intensive large-scale agricultural production at the expense of environmental conservation and food quality. One only needs to go and watch the movie 'We Feed The World', produced by Erwin Wagenhofer in 2005 (the most successful Austrian documentary movie ever) to get a picture of the unappealing endless number of greenhouses in southern Spain that focus almost exclusively on intensive tomato production. Erwin Wagenhofer, who is an urban dweller with little knowledge of agricultural policy, blames the corporate world for all this misery. Yet, in fact, intensive tomato production in Spain is a result of EU subsidies. The same goes for olive tree monoculture in Spain and Greece, overfishing in the Atlantic Ocean, excessive growing of low-quality wine in France and many other subsidised products.

All these practices are not just harming the environment but they also discourage innovation and tend to make food quality worse – why should these producers care about innovation or satisfy consumer taste if the money comes from Brussels anyway? The EU's Common Agricultural Reform (CAP) tries to address the mistakes of the past but it turns out that there are simply too many vested interests involved to accomplish any substantial reform. As much as 80% of its subsidies still go to the richest 20% of farmers, and the biggest single recipients of CAP payments tend to be giant agribusinesses and big, wealthy landowners. France continues to be the largest beneficiary of CAP money, taking around a quarter of all EU farm subsidies [25].

3.2.1 *Agricultural Policy after the Cold War*

In the 1990s, agricultural economists recognized that certain policies produced 'sub-optimal' results despite the rational social planning. They recommended a switch from production-tied subsidies to income-support subsidies. Agricultural income-support programmes included output and land subsidies, as well as decoupled payments with or without mandatory production. The new objective was to maintain a strong, healthy and environmentally sustainable agricultural sector. As a consequence, things like agro-biodiversity, food safety, decentralized settlement, and custodianship of cultural landscapes were declared to be the new public goods that are provided by farmers - after the old public good of maintaining food security became somewhat obsolete in view of the production surplus and the end of the Cold War. It was christened multifunctional agriculture and provided the best justification to keep agricultural economists employed as social planners and continue to use all the old planning models designed to calculate the optimal allocation of scarce resources where markets allegedly fail to do so. But did the markets really fail or are these public officials increasingly managing state failure?

There is increasing evidence that the new agricultural policies and the new justifications for government intervention in agriculture did not bring the expected improvements: direct payments were designed to mitigate the structural change that was expected to result from slightly more open agricultural markets as demanded by the WTO Agreement on Agriculture (AoA). Yet, direct payments proved to be an obstacle to structural change because they artificially increased the value of agricultural land and discouraged many farmers from becoming more innovative and competitive [26]. At the same time the new normative goals of agricultural policy to promote environmental, social and economic sustainability through compliance schemes (e.g. agro-environmental measures/labelling schemes in return for more direct payments and premium prices) once again turned out to be in the best tradition of government-sponsored research by agricultural economists, namely suboptimal: environmental improvements were relatively meagre and largely achieved through more efficient input technologies. In addition to that, a large evaluation of agro-environment measures in Europe showed that such measures rarely contribute to a real increase in valuable biodiversity [27].

As for the socioeconomic impact of direct payments, there seems to be a correlation between the amount of direct payments a rural region receives and its economic decline and subsequent impoverishment [28]. This is not

surprising considering the fact that a high dependence on direct payments is not an attractive way of life for the young people who want to be creative and participate in the new knowledge economy; apart from that, the private sector is reluctant to invest in subsidised regions because of the passive receiver mentality (that results from generous state support) and the relatively high costs of labour and land (pushed up indirectly through direct payments).

In spite of the timid opening of agricultural markets, agricultural trade hardly increased over the past two decades. One major reason for that is the AoA itself. It is primarily focused on a gradual improvement of market access rather than the reduction of domestic support measures. But, ultimately, it is domestic support measures that cause wrong market incentives that, again, result in overproduction and subsequent market access restrictions [29]¹⁰. The fatal consequence was that the amount of domestic support did not decrease but was simply moved from so-called 'actionable' subsidies (amber box of the AoA) to 'non-actionable' subsidies (placed in the blue and green box of the AoA)¹¹. It was assumed that non-actionable subsidies would not be trade-distorting but it turns out that they are. At any rate, this shift kept social planners employed and did not force anyone to look at theory. But are these policies sustainable and do they really benefit farmers? In consideration of what we know today, the answer is unlikely to be yes. A parallel development with a similar ambiguous outcome happened in the international arena where the primary concern was to help the poor in developing countries to become self-sufficient in food production.

3.2.2 *The theoretical thinking behind the Green Revolution*

In the 1940s policy makers in the United States agreed that developing countries must be assisted in the development of new varieties and modern irrigation systems in order to boost food production and avoid hunger and starvation. It was assumed that the private sector would have no interest in investing in technologies that serve poor farmers in developing countries. Therefore public investment in international agricultural R&D was declared to be a public good that must be managed by the public sector (following the Solow model). The resulting global public sector initiative is widely known as the Green Revolution. It was to a large extent a US-driven effort to improve food security in the non-aligned developing world as part of a global containment strategy against communism [31]. USAID and

the Rockefeller Foundation were the main financial contributors to the establishment of the first centres of the Consultative Group of International Agricultural Research (CGIARs) in developing countries. These CGIAR centres enabled Western scientists to work in well-equipped research centres in developing countries and design high-yielding varieties of major food crops such as maize, wheat and rice. The new varieties were subsequently distributed in rural areas through government institutions. The private sector was hardly involved, even though it later benefited from the scientific knowledge generated through this international undertaking. The research at these centres (CGIARs) contributed to significant increases in agricultural productivity and technology transfer to local universities and national research institutes in developing countries. Yet, the role of the private sector and especially the one of local entrepreneurs in the commercialization and local adaptation of the technological innovations was somewhat neglected.

There is no doubt that the Green Revolution greatly contributed to global food security through the excellent international agricultural research that was conducted at CGIAR centres during the Cold War. However, the interaction between Western scientists, who developed high yielding varieties, and local farmers in developing countries who adopted these varieties through the national seed distribution programs, was rather poor. This led to some long-term problems such as inadequate use of pesticides, insufficient maintenance and operation of irrigation systems by local people, little seed choice for farmers and monocultural practices [32]. In addition, farmers in marginal regions did not benefit to the same extent from these new hybrid varieties that were mainly designed for favourable agricultural conditions with access to fertile soil, irrigation as well as input and output markets [33].

Left-wing development activists point at these unintended side effects of the Green Revolution and tend to attribute the associated monocultural practices to the capitalist logic. Yet, as highlighted in the early case of the documentary of Erwin Wagenhofer, these undesirable side effects are a result of too little rather than too much private sector involvement. For example, public sector researchers based at CGIARs did not have to bother much about the real and complex set of problems that farmers face in the field or the particular consumer taste of different cultures. They could just focus on plant variety traits that would increase yields and then select the elite varieties and hand them over to national agencies for distribution. As a result, the pri-

vate sector may have had little interest to invest in the development and commercialization of new varieties in developing countries and compete with the public sector that distributed the seeds to farmers almost free of charge. Thus, the private sector largely stayed out of the Green Revolution. This explains for example why the greatest bottleneck in many poor developing countries is probably the absence of a local seed industry and seed choice. It also explains why many Filipino consumers prefer to buy rice from Thailand which is the greatest exporter of high-quality Indica Rice but actually never adopted high-yielding rice varieties. They say it simply tastes better than the rice varieties that were bred by the International Rice Research Institute (IRRI) and widely adopted by Filipino farmers [32].

3.2.3 *International agricultural research after the Cold War*

After the end of the Cold War, foreign aid was cut in almost all state budgets of developed countries and public sector funding for agricultural research decreased significantly [34]. Right-wing politicians were arguing that there is no need for further investment in CGIAR research because the Green Revolution has already largely achieved its purpose of eliminating hunger. This argument is quite cynical considering the fact that there are still over 800 million people worldwide that suffer from hunger and malnutrition. Left-wing politicians, in turn, were using the familiar but flawed argument that there is enough food for everyone if only it were better distributed. Agricultural ministries in developed countries would most certainly welcome this argument because it would give them a good opportunity to get rid of production surpluses. Yet, the fatal consequences of such forms of food dumping are widely known: local farmers in developing countries that cannot compete with donated food are forced to abandon farming because of lack of revenues. Thus such policies are likely to worsen food self-sufficiency and increase dependence on Western food aid. Even though the 'distribution problem' argument is still widely used by teachers in high-schools, it is even rejected by left-leaning development activists who embrace the paradigm that farmers in developing countries need to be assisted in growing their own food in a sustainable way.

Yet, the problem with Western Non-Governmental Organizations (NGOs) that pursue this approach in developing countries is that they generally dismiss the role of business and new technologies in agricultural development using the familiar argument that it would introduce a capitalist logic that is not compatible with the

local traditions. They believe that farmers should rely on their traditional low-input and low-tech practices. They may assist them in finding slightly better techniques of soil fertility management and integrated pest management, but in general farmers are encouraged to use the agricultural practices they would use anyway. Subsequently, these Western NGOs help them to export the harvested agricultural products to developed countries where they are sold under different kinds of environmental and social labelling schemes. Such a strategy resembles the top-down approach of the Green Revolution: both strategies assume that there is a sort of market failure because business does not care for the poor. This produces negative externalities such as increasing social inequality, hunger and malnutrition that must be addressed by responsible Westerners. The only difference is that one approach looks at modern technology as the solution whereas the other one sees it as a curse.

However, the ideological mindset of such NGOs is likely to harm poor farmers in developing countries more than the previous overemphasis on public sector R&D. Farmers need to become actively involved in the process of technological change and they need to learn how to take advantage of the emerging knowledge economy by combining traditional knowledge with new knowledge in their efforts to realize economic opportunities in the market. This will eventually lead to more self-confidence and entrepreneurship and result in increases in agricultural productivity and nutritional quality of the traditional food crops. This is especially true for Africa, which did not benefit from the first Green Revolution.

In 2001, the UNDP Human Development Report 'Making New Technologies work for Development' [35] attempted to counteract the misconception of the supposedly negative role of technology and the private sector in sustainable development and was promptly attacked by sustainable development activists. This is a pity because this report merely reminded policy-decision makers that there is Principle 12 in the UNCED Rio Declaration that emphasizes the important role of new technologies in sustainable development.

It seems that neither agricultural economists that helped shape the Green Revolution, nor Western NGO leaders that advocate participatory approaches in agricultural development can see any benefit in getting the private sector more involved in agricultural development and encourage local entrepreneurship. This may be related to the fact they tend to use theoretical concepts that might have looked reasonable in the Cold War economy, but are rather outdated in the new knowledge economy.

4 The new knowledge economy slowly changes the rules of the game

The two major driving forces of the new knowledge economy are the revolutions in information technology (IT) and biotechnology that took off in the 1970s and 80s. Both revolutions started initially at universities and were strongly supported by the public sector. However, when the first prototypes of commercial interest emerged, the university-based inventors decided to seek intellectual property protection for their inventions in order to set up their own businesses in the form of spin-off firms. Some of them eventually established highly successful companies that partnered with multinationals in the commercialization of the technology, others focused on licensing out their patented technology to whoever was interested in using it, and others again simply lost out to entrepreneurial young outsiders that quickly grasped the economic potential of certain clumsy prototypes and improved them to a level where they could become commercial successes [20].

The IT and biotechnology industries have matured over the past decade. As a consequence the costs of IT and biotechnology products and tools have decreased significantly and are now reaching a far wider customer base. Unlike in the old economy where most developing countries merely played the role of suppliers of primary commodities and lacked the critical base of domestic human capital to make use of modern technology to develop their home-grown technologies, the new knowledge economy allows them to participate in the global economy in a much more extensive way.

4.1 The effects of Information and Communication Technologies

Thanks to all the new communication and information technologies, new knowledge spreads more quickly and widely, international research networks become much more extensive and effective, outsourcing business activities from simple accounting to R&D has become an integral part of the strategies of multinational companies, and venture capital firms are increasingly investing in talented techno-entrepreneurs in developing countries. The resulting rise of many developing countries in science, culture, business and political power makes the jargon of North-South dialogue of many Western Development activists look increasingly old-fashioned. South-South business investments and research collaborations are growing five times faster than its North-South equivalent. In 2005, 35% of Foreign Direct Investment (FDI) in developing countries was

from other developing countries [36]. Moreover, many big companies in the South are starting to even buy up companies in Europe and the United States. This rise of the rest is taking the Western baby-boom generation by surprise. Their cultural paternalism and their ideologically-stretched version of welfare economics are at risk of becoming irrelevant, especially in view of the dynamic Asian economies, which are already fully embracing the principles of New Growth Theory.

4.2 The costs of not being part of the knowledge economy

There is a widespread prediction that the biotechnology revolution, powered also by the advances in information technology will eventually transform a rather dirty agrochemical and petrochemical industry into a more clean biology industry [37]. The potential economic, social and environmental welfare benefits of this transformation are enormous, and this time it is likely that developing countries with a critical domestic knowledge base will be at the forefront in the production of new goods that generate this type of welfare benefits.

If mankind is serious about protecting the natural environment and ensuring access to food, the growing demand for food over the next 50 years should not be met by further colonizing pristine ecosystems but by raising productivity on existing farmland; agricultural biotechnology is not just ideally positioned to meet this challenge but is also likely to produce new food products that are safer, more nutritious and tastier. The potential environmental and health risks of biotechnology must be taken seriously, but after ten years of experience and innumerable public risk assessment studies there is increasing doubt that existing genetically modified (GM) crops pose any risks that go beyond the risks known from conventional crops. Moreover, the ethical concerns raised about the current techniques of genetic engineering could quickly be overturned by the emergence of completely new transformation techniques and advances in genomic research. But one ethical concern will certainly not go away and that is the crucial aspect of social equity.

The private-sector driven biotechnology revolution may result in enormous social inequalities because the least developed countries that have simply no means, no critical knowledge base and no attractive markets to participate in this emerging sector may once again be left out. As a result the new products would merely improve the needs of affluent societies because they promise a high return on investment while the basic needs of the poor will remain unaddressed.

Paul Romer [4] points out that an exponential increase in knowledge leads to an exponential increase in the probability that new products and services will be created. These new goods and services generate innumerable new 'Dupuit' welfare triangles - but only for those societies that do not prevent them from being introduced and those that have sufficient purchasing power and market size to attract them. Therefore there is a high likelihood that the knowledge economy will even increase global inequality, unless national governments and international organizations design policies that ensure that the new technologies will also benefit and eventually empower people in least developed countries.

However, it would be a mistake to address the challenge by simply embracing a second green revolution [38] because, as explained above, the underlying principles of welfare economics are no more applicable to the rules of the new knowledge economy. The belief that public goods should be provided exclusively by the public sector ignores the fact that the private sector increasingly contributes to the production of public goods (e.g. clean technologies, more efficient use of natural resources) as well as public bads (e.g. pollution, inequality, risk) [39]. The public sector should therefore not assume tasks that the private sector can provide in a more efficient way and in better quality (more focused on consumer/client needs) but learn how to better play the role of a facilitator of private sector activities that generate large Dupuit welfare triangles (creating positive externalities) and decrease the dependence on goods that produce environmental and social welfare costs (eliminating negative externalities).

As shown in the first chapter, the generation of new goods with large social welfare triangles requires high fixed costs that are spent on investment in R&D, physical infrastructure, and product development and marketing. Often companies are unwilling to invest in the development of a new good unless the resulting market is expected to be profitable (and thus covers the high initial fixed costs). This also explains why the first prototypes of new technologies were almost always designed in university rather than corporate labs [19]. Throughout the history of technology we can always observe the same pattern: there is the curiosity-driven researcher funded by the public sector who has no immediate interest in business. But there is also the bold entrepreneur who may partly steal the knowledge generated by the curiosity-driven researcher, design a new product out of it, adjust it to market needs, patent it and finally commercialize it on a large scale. Both characters are

needed to create social welfare triangles. Sometimes the curiosity-driven researcher and the entrepreneur can be one and the same person. But often the inventor is not necessarily a good entrepreneur and the good entrepreneur is not necessarily good at inventing. At any rate, without the existence of smart entrepreneurs who are primarily focused on creating new markets that earn them large profits as temporary monopolists, the fruits of science could never translate into useful new goods and services.

4.3. National governance of the knowledge economy

The positive role of entrepreneurs must be kept in mind in the design of policies that aim at improving welfare in marginal areas. Effective rural development policies must combine agricultural, development and environmental policies with science and technology policy and the promotion of local entrepreneurship.

In the context of mobilizing science and technology for development, the public sector must first identify the technological innovations that could potentially generate large social and environmental welfare benefits in regions that tend to be ignored by the knowledge economy. It should then offer university research teams funding to develop prototypes of such desirable goods, or offer a generous reward to the research team that first develops a dependable prototype that is sufficiently attractive to be licensed out to the private sector [39]. Yet, it should not be the university but the government that does the licensing negotiations¹². The private sector may be discouraged from acquiring a new prototype if researchers overestimate the value of their invention and underestimate the fixed costs and the risks that companies face when commercializing a technology with uncertain market potential.

The government that funds R&D on a new technology that addresses certain social and environmental challenges may have a real interest in encouraging the private sector to use the resulting prototype and convert it into new goods and new markets. For that purpose, the government may waive licensing payments in return for certain reservations when it comes to the commercialization of the product (e.g. ensuring the research exemption for the patents obtained, privileged access of the product in markets with poor purchasing power).

If the prototype is still not attractive to the private sector because the expected market is too small to make a profit, the government can design additional incentives such as fast track regulatory approval and tax credits for

product development. Once a company is willing to take the risk because it expects to make a profit (thanks also to the additional incentives), it will be much more efficient and end-user focused than the public sector could possibly be.

4.4. Global governance of the knowledge economy

Often governments in developing countries may not have the means to offer sufficient incentives on their own to induce companies or research institutes to come up with products that would produce high social welfare triangles for their country. For example, improved orphan crops could save thousands of lives and significantly improve the health of the poor but neither the local private sector nor the national government have the means and the know-how to successfully invest in such improvements. At the same time, multinational companies that might have the know-how do not have any incentive to invest.

International donors could address these constraints by creating incentives for the private sector to produce such goods offering a generous prize for the first company or research organisation that is able to produce such a good [40] or offering an advance purchase that would boost expected demand [41].

Some people would denounce this as creeping privatization but the fact is that the new technologies that were derived from information technology and biotechnology make it increasingly cost-effective to include the private sector in the management of public goods. Generally these technologies permit smaller producers and more scope for competition [39].

4.4.1 The future role of CGIARs in biotechnology R&D

From 1996 to 2004, biotech crops have reduced the volume of pesticide spraying globally by 6 percent, equivalent to a decrease of 172'500 tons. The technology has also significantly reduced the release of greenhouse gas emissions from agriculture, which is equivalent to removing five million cars from the roads (due to no-till farming). The increase in farm income that resulted from the adoption of GM crops is equivalent to adding 3 to 4 percent to the value of global production of the four main biotech crops [42]. Moreover the adoption of transgenic Bt¹³ cotton in many developing countries turned out to have significant positive economic, health and environmental effects for small- and large-scale farmers alike [43]. All these facts just refer to GM crops and do not take into account the large economic and environmental gains that have been achieved by

using all the other tools of modern biotechnology such as tissue culture, marker-assisted breeding, gene silencing and genome mapping.

Why then do politicians often argue that agricultural biotechnology does not offer any benefits to society and the environment? This may be largely based on a generally hostile public opinion and vested interests that prefer the status quo in agriculture. Yet it also seems that agricultural economists are not really able to provide them with convincing arguments why agricultural biotechnology will also benefit the poor and the environment. Their scepticism about private-sector involvement may be related to the general distrust of monopolistic competition that drives the process of technological innovation.

In agriculture, this adds to the already existing scepticism related to the agricultural treadmill hypothesis, which treats technology as exogenous and implies that benefits from introducing technology in agriculture would not go to farmers but primarily to the seed and agrochemical industry. This clearly contradicts the numbers of Brookes and Barfoot [42], who calculated an increase in global farm income through the adoption of GM crops of a cumulative total of \$27 billion for the period 1996-2004, derived from a combination of enhanced productivity and efficiency gains. Obviously agricultural biotechnology must be more than just an agricultural treadmill. Moreover, it is wrong to reduce farmers to passive price-takers who struggle to survive in perfect competition. Farmers were always innovators and interested in collaborating with researchers; but the national agricultural policies can either encourage or discourage innovative farmer activities.

4.5 Farmers as innovators

The land grant college system in the United States was set up in the 19th century with the objective to promote applied science and stimulate economic activities in rural areas. The state universities that were established all over the country, had the explicit mandate to cooperate with the local farmers and support their efforts to find solutions to specific crop problems and support them in the development of agricultural innovations that have a commercial potential. This collaboration produced technological innovations, new agricultural products and new companies in agribusiness. Apart from stimulating economic growth it also contributed to the social empowerment of the rural areas in the United States. A similar development happened in Switzerland at the end of the 19th century. The first agricultural law was passed in 1893 with specific emphasis on the improvement of agricultural research and development and

in 1898 promoted with the establishment of national agricultural research institutes [44].

This successful partnership between the university researcher and the farmer has largely been abandoned in Europe and the United States, because agricultural research institutes have either become focused on publishing in peer-reviewed journals or they just do consulting work for their respective ministries of agriculture. Yet, New Zealand started to rediscover this old success story after it decided to liberalize agriculture in the 1980s. The Royal Institutes of New Zealand were semi-privatized (they are expected to partly generate their own revenues through the development of new goods and services) and agricultural research projects must be committed to increasing competitiveness and environmental sustainability through innovation, if they are to be funded by the state. This implies a close collaboration with business and the farming community.

Even though genetically engineered crops are not yet approved for commercialization, agricultural biotechnology is at the centre of this new agricultural policy in New Zealand. New Zealand's biotechnology industry generated an estimated revenue of \$811 million in 2005, with over \$250 million in exports (supplemented by \$160 million in manufactured agritech exports)*. The industry has helped to ensure the continued international competitiveness and efficiency of New Zealand's food and beverage sector. This focus on technological innovation did not just create a more diversified, competitive and environmentally sustainable agricultural sector (compared to the previous subsidy-based agricultural system) but also boosted the social and cultural empowerment of the countryside. New Zealand's farmers do not see themselves as victims of a new knowledge-based economy but as an integral part of it.

Rather than relying on a social planner, they learned how to take advantage of the opportunities of globalization. Moreover, farmers in New Zealand are not just asked to execute national sustainable policy strategies but encouraged to participate in the respective regional councils (set up by the national Resource Management Act) that develop locally relevant and feasible environmental policy strategies. These regional councils often recognize that there are no simple win-win situations but hard trade-offs when it comes to making competitiveness compatible with environmental sustainability, and the only effective approach to address this trade-off is investment in knowledge and innovation. This investment requires however that farmers organize research on short-term problems by themselves through a collective tax

and rely on the collaboration with public research institutes and the private sector when it comes to technological innovation that allows for a more efficient use of natural resources [45].

4.6 Crop research networks as a new form of international agricultural research

Some would argue that New Zealand is an exception. It has invested a lot in knowledge and human capital, is well-governed, has excellent infrastructure and highly developed input and financial markets. Poor developing countries where none of this applies would face a much bigger challenge to make technology compatible with sustainable development, especially to improve orphan crops that are largely grown by subsistence farmers. These farmers would not benefit from private-sector innovations because companies have no incentive to invest in poor rural economies; and, in case they would invest, farmers would lack the knowledge to use the new technology in a sustainable way. The arguments may sound reasonable but they underestimate the power of creative solutions.

The Cassava Biotechnology Network (CBN) started in 1988 as a global initiative to use biotechnology for the genetic improvement cassava. Its story is an excellent example to illustrate how creative thinking uses the potential of agricultural biotechnology for the benefit and empowerment of local subsistence farmers. Cassava is a typical orphan crop that is produced mostly by smallholders on marginal and submarginal lands in the humid and subhumid tropics.

CBN is based at the Centro Internacional de Agricultura Tropical (CIAT) in Colombia and consists of a loose network of stakeholders involved in cassava research, cassava farming and cassava business as well as international donors with an interest in cassava agriculture.

One goal of CIAT was to use CBN as a vehicle to get more involvement of the private sector and the farmer community in order to learn more about the effective demand for certain innovations in cassava agriculture. Once the areas of research that are likely to result in useful products for farmers (creating large Dupuit welfare triangles) are identified, members of CBN look for funding and the best partners worldwide to collaborate on joint research projects and to ensure successful commercialization of the expected new product. Thanks to the advances in modern information and communication technologies, international research collaborations have become much cheaper and also more effective.

CBN's tissue culture project illustrates well how indigenous knowledge can be successfully combined with biotechnology in the search for effective solutions in cassava subsistence agriculture. The project uses tissue culture techniques, which have been constantly improved over the past decades. CIAT's Biotechnology Research Unit (BRU) has developed low-cost cassava in-vitro rapid multiplication techniques in collaboration with a Colombian farmer organisation called FIDAR (Fundación para la Investigación y Desarrollo Agrícola). This comprises small tissue culture laboratories, cold chambers and greenhouses, built mostly with local material. The use of local material made the end product six times cheaper than the standard market version. Subsequently, local men and women were trained how to use their traditional knowledge about the locally available clean planting material and reproduce it in a tissue culture laboratory. The project proved to be very successful because the low yields of cassava agriculture are largely attributed to low quality and virus-infested planting material (stakes). It induced especially women to set up local businesses and specialize in the reproduction and sale of high quality cassava stakes in the region. Suddenly high technology ceased to be magic that could only be practiced by Western scientists but became a practical tool in daily life. This proves how the value of indigenous knowledge can be enhanced through the application of agricultural biotechnology; and it shows that agricultural biotechnology can be a tool of empowerment [46].

Final Remarks

Neoclassical Welfare Economics treats business and technology largely as producers of negative externalities resulting in welfare costs that need to be minimized through state intervention. It assumes that the global economy is exclusively characterised by the laws of scarcity and diminishing returns, and thus ignores the fact that knowledge is a non-rival good that does not become scarcer with increasing use. The creation and use of new knowledge therefore generates *increasing* returns in the form of new goods and services and leads to an ever more efficient use of scarce natural resources through technological innovation. Yet, the neoclassical comparative-static approach does not show these increasing returns and therefore sees market failure almost everywhere.

New Growth Theory, as illustrated in this article, highlighted the flaws in the previous concept of economic

analysis by showing that the partial equilibrium model that is often used to portray the welfare costs of business and technology in form of 'deadweight loss triangles' for consumers, is not telling the whole story. What these models ignore are the positive externalities that business and technology produce for society. These positive externalities are a by-product of the private sector's effort to convert knowledge into new goods and services. A company that decides to forego part of the existing production of a certain good and invest it in the production of a new good is not just making profits by creating a new market that gives it a temporary monopoly but also generates a new social welfare triangle called the 'Dupuit welfare triangle' that has hitherto been ignored in the comparative-static model of welfare economics.

Once the positive externalities of an innovation-driven private sector are recognized, it becomes clear why applied Welfare Economics itself might produce large welfare costs in the sense that its single-minded focus on eliminating the negative externalities is inadvertently making it less attractive for the private sector to produce positive externalities through technological innovation. This is especially a problem in rural areas where there are already weaker incentives for the private sector to invest.

The criticism of the principles of welfare economics is not new but well-documented in the economic literature of the past five decades. Yet, this criticism had little impact on textbook economics and public policy in general [46]. One exception is the area of science and technology policy, which grew in importance over the past decade in response to the emerging knowledge economy that was largely powered by the advances in information technology and biotechnology.

Science and technology policy is merely meant to strengthen global competitiveness of the already growing metropolitan regions and their innovation-driven industries. In turn, agriculture-based rural economies are seen as the losers of globalization and therefore treated like sick patients in public policy. It reflects an increasing divergence within governments between the departments that are in charge of development, agricultural and environmental policies and specialised in the management of negative externalities on the countryside, and the departments that are in charge of science, technology and economic policies and focused on the promotion of the positive externalities of technological innovation in urban areas. Such a divergence is creating a schizophrenic form of governance (depending on the government department you talk to you hear a different

story) and leads to a loss of public leadership. Moreover, the different policy treatments imply that rural areas are backward and therefore unable to take part in the knowledge economy; and, even worse for rural areas, the concept of sustainable development has been shaped by the doomsayers rather than the more forward-looking policy-makers who are in charge of promoting the positive externalities of the new knowledge economy. As a consequence, the potentially positive role of business and technology in sustainable development has been largely ignored by governments.

Apart from some initiatives in the area of public health, there are still few serious policy incentives for the private sector (through tax credits, generous awards, and advance purchase agreements) to develop and market new goods of high social value in regions that lack purchasing power and market size. Moreover, few policy-makers look at the potential of creating new markets in rural areas by transferring already mature technologies that have become very user-friendly and cheap (and are therefore less dependent on high-skilled labour); rural entrepreneurs may find new ways to employ these technologies to solve local practical problems. There are already plenty of examples that illustrate how machine tools can be tailored to local needs by local grassroots inventors in developing countries [47].

The welfare costs of not being part of the knowledge economy are growing every year. The policies intended to protect farmers from the forces of globalization, the environment from the introduction of new technologies, and the poor from using these new technologies in combination with their local knowledge; are inadvertently making things worse because:

- ⇒ heavily subsidised rural economies in industrialised countries experience economic decline due to absence of private sector investment and the emigration of the young (they want to be creative and not dependent on subsidies)
- ⇒ new technologies that would enable a more efficient and sustainable use of environmental resources are not being used, and
- ⇒ the poor are not supported in their efforts to search for new ways to combine traditional knowledge with new technical knowledge that would create new business opportunities and create new local goods and services.

The reluctance to abandon the principles of welfare economics in textbooks and public policy may be attributed

to the power of habits and the refusal to recognize changing circumstances. Those who dominate culture, politics and academia today in affluent societies used to be the enthusiastic young followers of the social movement in the 1970s. At that time, they were challenging the uncritical mindset of their parents. They accused them of indulging in consumerism, being uncritical toward state paternalism, and showing indifference towards the misery in developing countries and environmental destruction. Today many of these former protesters have themselves assumed the role cultural paternalists that try to impose their increasingly inadequate view of a 'post-materialist' or 'value-based' society on the next generation.

The demand for more value-orientation in politics is often linked to the belief that the adoption of shared community values on the societal level would lead to a more inclusive and less self-interested society. This belief represents a typical example of ecological fallacy: informal rules that work in a community are unlikely to work as formal rules on the societal level (and reversed) because community behaviour is based on a social/psychological rationality, whereas individual behaviour in society is based on a political/economic rationality [6]. This insight does however not seem to affect the popularity of post-materialist values in the voting and shopping behaviour of people in affluent societies. By buying organic and fair trade products consumers believe to reveal their personal ethical responsibility and make a political statement against the global business that puts 'profits over people'. As citizens they manifest their discontent with globalization by voting for far-right or left wing parties that are presumably more concerned about protecting community values than the political establishment. This generates an atmosphere of we (a community that is based on the principles of fairness and reciprocity) versus them (a society supposed to be dominated by greed).

Political actors and supermarkets have become skilful in exploiting the subliminal distrust in the formal institutions of the market economy and democracy (are based on the assumption that people are primarily driven by self-interest and the improvement of material well-being) by emphasizing the shared community values. Even though there is increasing evidence that ethical shopping is not a sustainable way to improve the well-being of the poor and the environment [48], supermarkets look at it as life-style products that make people feel good about themselves. Moreover, it improves their public image because they are seen as value-driven as opposed to profit-driven.

Governments respond to the public pressure created by angry fringe parties and social movements that claim to represent community values, not by offering good counter-arguments why it makes no sense to adopt community values on the societal level, but by giving these demands political legitimacy in expectation of winning more public legitimacy themselves. They do so by arguing that these values would reflect the aggregated preferences of society that can be captured in the social welfare function in welfare economics. By passing regulation that is in accordance with these normative preferences (but often in contradiction to scientific evidence and best practices) they increase their popularity and at the same time can claim to be 'rational economists'.

The subsequent export of such 'value-based' regulation to developing countries (offering trade preferences and foreign aid in return for the adoption high regulatory standards) is thus an export of values rather than science and know-how. This cultural paternalism stifles local economic activity and discourages rural entrepreneurship in poor developing countries because these regulations often turn out to be highly burdensome for small local companies. In turn, they create more business opportunities for Western companies, NGOs and consulting firms because they either have the financial endowment and experience to comply with this regulation in developing countries or get funding to implement it in the first place.

The value-driven economy is therefore likely to result in more economic inequality rather than a more 'humane world'.

After all, peaceful interaction on this planet does not require people to share the same values [49]. In fact, enlightened and active citizens are self-critical toward their own value-system which they do not just see as an authentic expression of personality or culture. As Max Weber would say, they embrace an ethic of responsibility rather than an ethic of conviction [50]. Morally and culturally evolving citizens also show a curiosity for people that do not share the same values. Culture is not something that grows out of a homogenous community but is rather the product of cross-fertilization that results from the interaction and mutual learning of different cultures in a heterogeneous society [49]. Moreover, values shared by a homogenous community may not just be based on reciprocity and fairness but also include dangerous stereotypes and prejudices that are the product of fear and ignorance [51].

New public leadership must resist the temptation to uncritically endorse community values, prevent the divergence of political strategies between the different government departments, and come up with more creative policy approaches to sustainable development that aim at facilitating rather than avoiding change in rural areas. Such new creative policies must not be invented from scratch. It just requires a willingness to learn from best practices and the experience of national and international policy initiatives that embraced New Growth Theory in their rural development strategies. The land-grant college system in the United States in the 19th century as well as the international Cassava Biotechnology Network (CBN) and the innovation-driven agricultural policy of New Zealand in the 21st century illustrate that New Growth Theory can successfully contribute to sustainable economic development in rural areas, independent of time, culture, geographical location, and stage of economic development. Yet, these success stories are all based on strong public leadership, a political will to embrace change, and active citizens that focus on self-improvement.

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Notes

1. Abram Bergson introduced the social welfare function in 1938 [1]. He sees the function as the aggregated end-product of the values held unanimously by a certain society rather than a method of reconciling divergent value-systems as Kenneth Arrows suggested in his refined version of the social welfare function in 1963 [2].
2. In defense of Marx it must be admitted that he had not a comparative-static but a dynamic view of economic development and consequently recognized technology-driven globalization as a powerful source of economic growth. Yet, since the student protesters looked at Marx as a prophet rather than an economist [8] they were not able to recognize it.
3. Some influential former left-wing baby-boomers eventually became frustrated with Applied Welfare Economics. Yet, rather than looking for better economic theory, they tended to stick to the old principles of ,Neoclassical Economics (which they were taught in school in the 1970s) but just skipped the social welfare function and re-fashioned themselves as neoliberals or neoconservatives. Their policies were quite influential over the past decade but are now widely discredited. They are not discussed in this article because their interest in rural development policy was always rather marginal.
4. Policies that are based on the Theory of Incentives are more dependable and effective because they take into account the Principal-Agent Problem in the institutional design and thus avoid moral hazard and adverse selection. The Principal-Agent Problem is discussed in detail in a previous ATDF Journal article [15].
5. The great majority of possible new goods fail to provide sufficient utility for a sufficiently large market or are unlikely to be introduced in the first place (the fixed costs are too high and the benefits too low). New goods that eventually succeed in being adopted tend to significantly improve the efficiency of the production of an already existing good, or replace an old low-quality good entirely. New goods can be tangible (e.g. bridge) or intangible (e.g. technical instructions). They require high fixed costs in the process of development and production which are to be compensated by a higher product price or a higher user-fee (e.g. bridge toll, royalty fee). However, intangible goods (e.g. technical instructions, new designs, etc.) are inherently different in nature, because unlike physical goods, they can be used over and over again at no additional cost [8].
6. The marginal cost of production indicates any additional cost required to produce a next unit. This mar-

- ginal cost curve is flat rather than increasing because it only represents the variable costs of production (below the line) that are assumed to remain constant with increasing production in view of the low and relatively stable reproduction costs of an innovation.
7. Technological innovation allows for a decentralisation and decomposition of public utilities (unbundling). Public utilities were previously thought to be natural monopolies that had to be state-run (e.g. postal service, electricity, railway, telecommunication). Today the more liberalised market environment and new technologies in these network industries allows companies to compete for the operation and management of these distribution networks. This may mark the slow transition from a public utility management to a market-driven commodity business. Decentralisation of energy production may become a reality on the long-run when more alternative energy technologies become available (e.g. micro-power plants based on hydrogen, organic waste or solar energy).
 8. E.g. new orphan crops varieties with higher productivity and enriched nutritional quality, orphan drugs against communicable diseases (e.g. Malaria vaccine), alternative energy-, bio-, material technologies that accelerate the transition from a polluting petrochemical into a more clean biological industry.
 9. A homogenous product has a certain uniformity that is generally accepted by traders. The potential to increase the value of the product through an increase in quality, taste or variety of the product is not taken into account.
 10. Influential agricultural trade economists such as Kym Anderson still rely on comparative-static trade models and consequently ignore the welfare surplus that is generated through the introduction of new goods. Generous direct income support up to a maximal annual level of farmer income (and supported by Anderson) decreases the farmers' incentive to earn more through innovation and entrepreneurship. And this again may slow down the generation of increasing returns through the creation of new agricultural goods and services. At the same time, it increases the incentives to continue to produce the already existing agricultural products with decreasing returns (farmers who would have left agriculture otherwise, continue to produce in order to receive direct payments). Therefore direct payments are not neutral but force governments to uphold market restrictions (increasingly in the form of non-tariff trade barriers). Because Anderson et. al [30] cannot find these undesirable developments in their trade models, they continue to insist that the potential contribution to global welfare would be enormous by removing agricultural tariffs but minimal by removing agricultural subsidies.
 11. In WTO terminology, subsidies in general are identified by "boxes" which are given the colours of traffic lights: green (permitted), amber (slow down — i.e. to be reduced), red (forbidden). Export subsidies are usually prohibited and therefore fall into the red box. This is however not strictly applied in agriculture where export subsidised are still tolerated (and therefore there is no red box for agriculture). The amber box contains all trade-distorting domestic support measures. Any support that would normally be in the amber box, is placed in the blue box if the support also requires farmers to limit production. Green box subsidies are meant to be non-trade-distorting. There are also exemptions for developing countries sometimes called "Special and Differential Treatment or 'development' box".
 12. This is not to prevent researchers from becoming entrepreneurs themselves. In case they themselves want to become entrepreneurs, patent ownership should be handed over from the university to the emerging entrepreneur. It could serve as a first asset of the new spin-off firm. The fact that the emerging entrepreneur does not have to pay a royalty fee to the university in the early stage when there are only costs and no revenues, makes it more likely that the young firm survives this precarious first stage. Instead of relying on the licensing revenues, the university could buy a stake in the emerging firm. This would give the firm more support in the early stage and the university more revenues in a later stage when the new good becomes a commercial success.
 13. *Bacillus thuringiensis* (Bt) is a naturally occurring bacterium common in soils throughout the world. It is also a natural insecticide with unusual properties that make it useful for the control of various types of pests.