Design systemic innovation policy for regions in developing country:

Case of Zhejiang, China.

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A thesis submitted to the faculty of
The University of Nijmegen
in partial fulfillment of the requirements
for the degree of Master in the
Department of Human Geography

Nijmegen

October, 2006

Supervised by

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Abstract

Innovation policy has been a dynamic research area in innovation study. At present, numerous approaches have been verified and suggested in relation to the innovation policy formulation. However, less attention is paid to regions in developing world. An attempt is made in this thesis towards that direction. Firstly, I argue that from system of innovation theory perspective, innovation policy practice for regions in developed world is a problem solving based process, due to the path dependency of innovation policy and the development level of advanced economies. Secondly, as regions in developing world to certain level can not be deemed as regional systems of innovation, the policy departure point should be constructing the necessary components and relations of a system of innovation. Then, systemic approaches concerning innovation policy making can be applied. To support this argument, the innovation policy practice of Zhejiang (China) is examined by the framework developed in the theoretical section of the thesis. It is concluded that without this innovation policy departure point and subsequent systemic approaches concerning various aspects of innovation policy practice, even a prudentially elaborated innovation policy package would miss vital ingredients of a system of innovation. This, of course, undermines the innovativeness of regions in developing world.

1 Introduction

Over the last decade, regional innovation policy has moved to the front in innovation study. The regional innovation policy formulation was shaped by a more systematic perspective, in comparison with the previous linear perspective which overly focuses on innovation inputs. Numerous rationales and concepts have been discussed and verified in this field.

It is observed that most studies of regional innovation policy focus on regions in developed world, very little attention has been paid to those regions located in developing country (Intarakumnerd et al., 2002). This might be caused by the thought that innovation is somewhat an extravagant notion for these underdeveloped regions, as their status of social-economic development is relatively low. However, from a system of innovation perspective, innovation was understood as a key factor in economic catching-up process of some countries (e.g. the U.S. and Germany in 19 century, Korea and Singapore in 20 century) when they were relatively underdeveloped in history (Freeman, 2002). It would be reasonable to argue that the significance of innovation for developing economy remains in today's world. Thus, this points to a currently relative ignored area of how to apply the systematic approaches in innovation policy to regions in developing world? An attempt is made in this thesis regarding this question. Firstly, I argue that from system of innovation theory perspective, innovation policy practice for regions in developed world is a problem solving based process, due to the path dependency of innovation policy and the economic development level of advanced economies. Secondly, the theory of

system of innovation was originated from academic research on regions in the developed world, thus it should not be taken for granted that regions in developing world are regional system of innovation in the same sense. Thus, the policy departure point should be constructing the necessary components and relations of a system of innovation. Upon the completion of this first step, systemic approaches concerning innovation policy making can be applied.

In order to verify the main question of this thesis, that is, how to develop innovation policy for regions in developing world by applying the systemic approaches and concepts, several sub questions are made. Served as the themes of subsequent sections in the thesis, these sub questions are:

1. What is the link between innovation and regional economic development and growth? And why the innovation capability is crucial to regions?
2. Why innovation policy matters to regional innovation capacity building? To what extent the public policy intervention is significant to a regional innovation system?
3. What is the state-of-the-art innovation policy study from system of innovation theoretical perspective? How could one theoretically examine the common process of innovation policy making? This paradigm may include a. the departure point of innovation policy design; b. the conceptual frameworks to pinpoint the causes of failure and obstacles hindering the innovating process in a region, from the system of innovation perspective; c. the operational innovation policy instruments that could transform the diagnosis into tangible action; d: the evaluation of the policy instruments and the afterwards necessary revision.

4. What should be made differently, if one applies the abovementioned process of innovation policy making to the regions in developing world?

Following these questions, the thesis is structured as follows. The next section I present the linkage between innovation and economic growth, in order to the highlight the importance of innovation in today's economic development and growth. Section 3 discusses the issues of why public intervention and innovation policy is needed for increasing regional innovativeness. A brief review of some studies regarding the innovation policy issues in developing world is presented in section 4. In section 5, I firstly verify the problem solving based process in making innovation policy for developed regions; introduce some systemic approaches suited for different stages in this process. Secondly, I argue that developing economies usually lack of some necessary components and relations which make up a viable systems of innovation. Thus, innovation policy departure point for regions in developing world should be constructing these basic ingredients, then systemic innovation policy making approaches can be applied. A case of innovation policy practice in Zhejiang, China is presented in section 6, followed by some criticisms from the perspectives discussed in section 5. Finally, conclusions are made in section 7.

2 Innovation and economic growth

Innovation is widely seen as a curial factor in generating economic growth and development and hence increasing the overall welfare in the society (Edquist, 1997, Lundvall, 1992, Nelson, 1993, Niosi, 1993). From the economic perspective,

innovation and knowledge are keys to economic development and competitiveness for firms, industries, regions and nations. The discussion below is to justify the tight link between innovation, knowledge and economic growth from various angles.

2.1 Historical evidence and current demand

Historically, innovation and knowledge combined played a decisive role in the economic development, in different ground breaking period of social progress. Take industrial revolution for example, it is argued that the key initiation was the innovative scientific knowledge in 17 century and the enlightenment of 18 century (Mokyr, 2002). According to Mokyr, the latter could in some way be perceived as breakthrough in social knowledge which is equally significant, as innovation doesn't merely concern technological advance. Similarly, the industrial catching up of the U.S. and Germany in late 19 century and that of later industrialized countries, such as Korea and Singapore in late 20 century, is also largely attributed to the knowledge and innovation (Freeman, 2002). However, a distinction needs to be made here, in Germany and the U.S., what led the economic growth were the innovation driven increase in productivity and the radical technology innovation in new industries, e.g. chemical and machinery (Viotti, 1997). While incremental technological progress in emerging industries such electronic and electric was the major pattern for Asian late-comer economies, e.g. Korea, Taiwan, and Singapore, to succeed in the second half of the last century.

In the current era of globalizing economic development, innovation and

knowledge are now the determinant factors in economic activities. This is reflected by two changes, one is the acceleration of production, appropriation, exploitation and consumption of the existing knowledge in the current global economy. Another is the rapid knowledge expansion in a slew of scientific and technological areas, meaning an economy could benefit more from the innovative breakthrough of scientific and technological frontiers, for instance, new products, new patterns of production, marketing and distribution, new service, etc. (Borras, 2003).

2.2 Innovation driven knowledge economy

Another account of innovation and knowledge influence on economic growth is related to a popular theme that the current mode of economic development is knowledge-based (Cooke, 2001, Foray and Kahin, 2006, Nonaka and Takeuchi, 1995, Smith, 2000). The modern capitalist economy relies more on the knowledge and technology, and less on the traditional factors of production, such as labor, capital and land (Druckner, 1998). The role and importance of knowledge has been more significant than ever in the past. With respect to the changing role of knowledge, Smith (2000) provided four basic views. First, knowledge is becoming an essential factor of production, in both quantitative and qualitative sense. Secondly, knowledge itself has transform into a major type of product, since the trade of knowledge is flourishing in the world economy. Thirdly, the codified knowledge has been more significant in the economic knowledge base of organizations. Finally, the advancement in information technology to large extent lifts the constraints of

collecting and diffusing knowledge, which further dynamizes the use of knowledge.

The transformation from traditional economic development model to a knowledge-based economic model is now observed among countries participating in the world economy. OECD (1999) reported that all OECD economies have moved towards knowledge-based economy, although with differing paces. Similar situation also takes place in some Asian later industrialized economies, such as Taiwan (Chen and Lee, 2004), Korea (Dahlman and Anderson, 2001), Singapore (Tan and Phang, 2005), as well as in some developing economies such as Russia (Watkins, 2003) and China (III Wilson, 2005), even though the transformation in these developing economies seems more directional than substantial.

2.3 Innovation as a component in economic growth models

The importance of innovation has been reflected by its recognition in the conventional economic theory through time. Early neo-classical economics didn't take the effect of knowledge and innovation into modeling, technology changes was seen as exogenous factor to the economic production (Solow, 1956), production technology was considered as public goods which could be acquired equally by firms (Verspagen, 2005). However, started from 1950s, a number of neo-classical economic models incorporated the role of technology, and made it an endogenous element of economic system (for a thorough review of this evolution, see Verspagen, 2005). Followed this trend, since 1980s, in the two major approaches that focus on the technology and economic growth, namely, the neo-classical new growth theory and

the evolutionary theory, the roles of technology and knowledge have been firmly added into the formal modeling.

2.4 Empirical evidence of the relation between innovation and economic growth

Along with the theoretical discovery of the significance of knowledge and innovation, the empirical evidences are fruitful. At the country level, Eaton and Kortum (1999) analyzed patent and R&D data in five innovation leading countries, and found both innovation and technology transfer positively affect national economic growth in varying ways. At regional level, the positive link between innovation and economic performance in Europe has been identified, based on the RINNO database (Howells, 2005). At the sector and firm level, it is reported that in OECD countries there is a positive and strong relationship between R&D and output or productivity growth (Nadiri, 1993). Nevertheless, there also has been study pointing to the adverse result, for instance Ulku (2004) analyzed patent and R&D data for 20 OECD and 10 Non-OECD countries for the period 1981-1997, and while his finding confirmed the positive relationship between per capital GDP and innovation in both type countries, there is no constant returns to innovation in terms of R&D. This, as Ulku argued, may imply that innovation doesn’t lead to permanent economic growth.

What could we conclude with respect to the relationship between innovation and economic growth? Firstly, innovation doesn’t merely matter to economic growth. It is now a key factor to economic growth, both for developed and developing areas, as the global trend of pursuing innovation driven economic growth strategy at various

geographical levels, in different continents shows. Secondly, as innovation is the major determinant factor for different rates in regional economic growth (Fagerberg, 1987), building innovative capacity should be a new focus in business competition for areas in world economy. This applies to both developed and developing areas. On the one hand, for developed areas, the gap between other conditions that are influential to the economic growth such as productivity and infrastructure become less obvious, hence innovation offers a new arena for these areas to put effort on in order to keep the competitiveness. On the other hand, innovation for the developing areas has been more crucial in comparison with the past, as the technology transfer and diffusion in the frontiers become increasingly difficult, and exploitation of the existing technology will eventually come to an end. Take newly industrializing countries in Asia for example, before 1983 the large scope of technological transfer was the main reason for high growth rate, now innovation has replaced it as the new driving factor (Fagerberg and Verspagen, 2001).

3 Why do we need innovation policies?

Even though innovation policies at different geographical level, by differing theoretical perspectives, are now widely adopted by a great number of authorities, it is still necessary to discuss the reasons of innovation policy intervention so as to logically justify the public action in relation to innovation and to have conceptual insights for possible areas that could be improved by policy effort. Derived from various analytical starting point e.g. politics, market operation, system of innovation

theory, etc., there are at least four convincing argument could be made to verify the validity of public innovation policy, and they are presented in the following. As the main focus of the thesis is regional innovation policy, the discussion is accordingly kept at regional level.

3.1 Political demand

The first argument is related to the political demand with a basic assumption that the primary objective for the regional government is to create and sustain the wealth of the region by means of economic growth. As presented in section 1, innovation is understood as a key factor in economic growth and international competition, hence to promote the innovation capacity directly contribute to the success of regional economy. Consequently, for government, it is imperative to actively to engage in facilitating innovation activities, or even constructing innovation capability through public policy instrument, for the sake of regional competitiveness and welfare.

Before the government takes any action, a critical question must be discussed as could the societal innovation demand be met by existing societal mechanisms (e.g. market mechanism or current institutional settings)? If sufficient innovating activities could take place within the existing societal mechanism, then there would be no reason for the government to intervene in such a self-fulfilling process. However, research in innovation study has identified, mainly, two types of failures, namely, the market failure and the system failure, in the process of innovation creation, and these failures are commonly embedded in almost all type of regions.

3.2 Market failure

The market failure of innovation refers to that the production of innovation could not be sufficiently supported by market mechanism, which leads to poor innovation performance. It is particularly true in the field of scientific and technological R&D, when certain kind of R&D generates enormous public benefit while the private innovation actor undertaking the R&D has little financial return, thus this type of R&D would be underinvested (Arrow 1962, Nelson, 1959). From the knowledge perspective, in such case of R&D underinvestment, for private innovation actors, the knowledge associated with R&D shows three general characteristics that hinders the innovation process, *uncertainty* means private actors couldn't anticipate the result and benefit of R&D; *inappropriability* reflects the fact the overall benefit from R&D could not be exploited by private actors; *indivisibility* relates to that to bring about any innovation, a certain level of investment in R&D is always required (Lipsey and Carlaw, 1998).

Regarding the classification of market failure, two researchers both provided fruitful insights albeit from slightly different angles. Gustafsson and Autio (2006) concluded five major market failures in terms of knowledge creation and use, (1) the uncertainty and risk in R&D activities; (2) the failure to appropriate innovation and new knowledge efficiently; (3) information asymmetries in the economy; (4) failure to deliver the wider value of new knowledge for growth in economies; (5) undervaluation of public good of technologies in firm strategies. Pavitt and Walker (1976) outlined 4 types of market failures (or imperfection as used in their paper) by

paying attention to the working of the market system, (1) competence failure, resulting from lack of technical competence within industrial firms or from lack of knowledge about the essential organizational ingredients for successful innovation; (2) information failure between users and producers of innovations, especially in consumers' goods and in government service markets; (3) incentive failure refers to inadequate or inappropriate economic incentives and rewards for desirable innovations, resulting from the general industrial climate, or from the degree of competition or monopoly, or from the workings of the patent or the tax system; (4) investment failure implies inadequate investment, by industrial firms in longer-term more radical innovations, because of short-term time horizons and risk aversion.

One interesting criticism on the market failure in relation to innovation policy is that "market failure approach is too abstract to be able to guide the design of specific innovation policies" (Chaminade and Edquist, 2006), while it might apply to early theoretical elaboration of market failure with neo-classical economics origin, such as Arrow (1962) and Nelson (1959), it appears less applicable to the two classification of the market failure presented above. Both two works explicitly pointed out concrete problematic areas where public intervention could take part in. Nevertheless, as an approach to guide innovation policy, market failure does have some weaknesses, for instance, it focuses mainly on the industrial R&D which leads to a tendency of leaving innovation solely to public support and private innovator in industry. It doesn't touch much of the cause and process of innovation, thus using market failure as a departure point to design innovation policy seems more helpful in supporting the creation of

innovation. It seems failed in promoting innovation activities in a more active way, due to lack of insight of innovation process.

3.3 System failure

The third argument regarding the public innovation policy intervention refers to system failure which is derived from analysis based on system of innovation theory. The system of innovation theory was originated from comparative study focusing on R&D performance between different industrialized nations during late 20 century. Over the last two decades, it has soon emerged as a mainstream theory in academia. Three observed variants of the theory are widely used as theoretical bases in innovation related study. In addition to the early work of national system of innovation ((Freeman 1987; Lundvall 1992; Nelson1993; Niosi et al. 1993), regional system of innovation theory deals with innovation research at regional level (Acs, 2000; Autio, 1998; Braczyk et al., 1997; Cooke et al., 2000; De la Mothe and Paquet, 1998), sectoral innovation theory mainly concerns the innovation occurs within industries, product areas, or entire value-added chains (Breschi and Malerba 1997; Carlsson 1995; Malerba and Orsenigo, 1997; Nelson and Mowery 1999).

Among numerous economic theories in which innovation has, more or less, a role to play in the economic production process, system of innovation theory seems to be the first one systematically place innovation at the centre of economic development. Among various version of definition of system of innovation, Edquist (1997) defined it as “all important economic, social, political, organizational, and other factors that

influence the development, diffusion, and use of innovations", organization and institution are the two basic components of the system. In such a system, organizations are formal structures with an explicit purpose and they are consciously created, and institutions are sets of common habits, routines, established practices, rules, or laws that regulate the relations and interactions between individuals, groups and organizations (Edquist and Johnson, 1997).Thus, from the system of innovation perspective, what could potentially go wrong in a system then can be identified as organization, institution, the interaction between organizations, the interaction between institutions, the interaction between organization and institution, and finally the system itself constitute the last potential layer that failure could take place. I then examine these system failures respectively.

The failure of organization

In a system of innovation, the types of organizations vary according to their function in the production, diffusion, assumption of innovation and knowledge. This implies that organizations in a system don't merely refer to those who directly contribute to the creation of innovation, such as, university, R&D department in the firm, public research lab. Also, organization could be those who play crucial role in transforming innovation, e.g. technology agency, consultancy, technology centre; in transforming scientific result into commercial product, such as firm's commercialization department, association of consumers and etc. In addition, those organizations without directly links to the innovating process, should also be included in the system of innovation, they could be, government and organization affiliated to

government who makes regulations, such as innovation promotion centre; various kinds of educational institute; association of specific industry or cluster; and infrastructure which support the basic functioning of a system of innovation.

All these organizations in a system of innovation could involve malfunction in the innovation process. With respect to innovation production, innovation producers could fail to produce innovation due to weak research competence in university and public lab, and inability of firms (Lundvall and Borras, 2005; Smith, 2000). In the process of innovation diffusion, possible failure lies in that innovation could not be diffused efficiently and timely from its producer to its potential user, due to poor work of innovation diffusion agency. In terms of the use of innovation, the final user of innovation might not be able to commercialize the scientific and technological innovation to make profit, caused by lack of absorptive capacity e.g. poor managerial skills (Lagendijk, 2000). Similarly, government could fail in forming a supportive environment and institutional setting for innovating (Martin and Scott, 2000), in design and execute desired policies (Hadjimanolis and Dickson, 2001; Justman and Teubal, 1986), and in inefficiently integrate various policy regarding innovation. Finally, there is so called infrastructural failure (Smith, 2000) which indicates the inadequate provision of both general physical infrastructure e.g. transportation, communication, and knowledge infrastructure (Smith, 1997) such as education institute, facility needed for R&D, platform of knowledge sharing and trading, etc.

The failure of institution

Institution in a system of innovation refers to the “rule of the game”. These rules

could be formal law and regulation (Smith, 2000), and informal ones such as social norms and value, or culture (Carlsson and Jacobsson, 1997). According to Edquist and Johnson (1997) and Smith (2000), the formal law and regulations normally include general legal systems regarding the contracts, employment, intellectual property e.g. patent and copy right, government regulations of bank conduct, regulations of investment and other financial activities and so on; and informal institutions refer to customs, traditions, work norms, common practices, norms of operations, political culture and social culture e.g. public opinion of entrepreneurship, etc. Potential failure could take form as lack of institutions, meaning there is no viable institutions which are demanded in a system; and as ineffective or inefficient institutions, in both cases the innovation process can be under-supported.

The failure of interaction between organizations

A prerequisite of a properly functioning system of innovation is that different organizations should interact in a smooth and constructive way. Here the interactions are not only the ones between different types of organizations with respect to the innovating process, i.e. knowledge producers, knowledge users and intermediaries, but also the interactions between organizations in one category. Inefficient cooperation between knowledge producers, knowledge users and intermediaries will cause problems in a system, such as inability to commercialize the scientific knowledge, slow response to the pressing industrial technological demand. Likewise, if organizations in a same category fail to interact in a appropriate way, it will also poses a negative impact on the system, for instance, knowledge users with same

demand overly compete to each, hence no network of interactive learning will be established.

The failure of interaction between institutions

As there are normally a numbers of institutions co-exist in an innovation system, thus, a latent problem lies in the mismatch of different institutions which may hinder the system to fully exploit the innovation potential of a system. For instance, it may exit the complementarity problem between financial regulations and regulations to promote venture investing; or it may be the contradictions between Hard and soft institutions (Edquist & Johnson, 1997). Another potential source of problem pointed out by Christensen et al. (2003) is the coherence between different regulations, whether the isolated regulations could be synthesized under the theme of promoting innovation.

The failure of interaction between institution and organization

This type of failure mainly refers to that institutions fail to encourage the innovating process in organizations, such as the requirement for bank loan is too high to business start up with urgent demand of financing R&D projects, or inflexible employment regulations unsupportive to R&D personnel move.

The failure at system level

Some problems occur at the system level, meaning all system elements are involved in causing the problems. One commonly observed failure is the so called, “lock-in” in a system of innovation, innovation organizations are not able to adapt to new technology, new pattern of production process, and new business model. Another

one is that different innovation organizations form too strong network which leads to ignoring the new knowledge outside the network, or being unable to exploit it due to the rigidity of the network; or too weak network which prevents innovation activities demanding collaboration between innovation organizations e.g. interactive learning or establishing industrial norms and conduct. The causes for such failures are often related to the various organizations and institutions, thus, the solutions should take a holistic perspective into account, meaning that the object of interventions is the whole system of innovation instead of the components of the system.

3.4 Social-cognitive failure

Aside from market failure and system failure which are deemed as traditional rationales of innovation policy making, Gustafsson and Autio (2006) proposed another type of failure that may cause sub-optimal innovation performance in a system of innovation, even in the absence of the two former. They argued that, both market and system failure rationales failed to address failure in sense-making process among various innovation actors in a system of innovation, the deficient socialization in innovation and innovation activity form the so called, social-cognitive failure. According to their observation, innovation actors in a system are bounded by existing sense making frame work, value system and institutions, thus they may fail to understand or make consensus on the market evolution and emerging technology opportunities. With out knowing their possible roles and associated cost and benefit, innovation actors would be relevant to actively engage in the innovating process. To

avoid the social-cognitive failure, they pointed to enhancing the inter-organizational macro-culture and cognitive group by establishing efficient community of practice.

To sum up, satisfactory innovation performance is not a direct result of un-intervened functioning of a system of innovation. The market mechanism and current institutional setting that constitute a system of innovation, *de facto*, cause numerous failures or imperfections in achieving sound innovation performance expected by stakeholders in a system of innovation. Several reasons of these failures and where the failures may occur are recognized in this section. A noteworthy advantage of clarifying why innovation policy intervention is needed is that it doesn't merely justify the "why" question, it may also be the source of conceptual framework providing sensible solutions to resolve these failures.

4. Studies on innovation policy of regions in developing world

4.1 Linear model vs. Systemic model

Innovation policy study has been a dynamic research area in the last decade, given its potential efficacy in promoting economic growth, as expected by scholars and policy makers. Due to lack of proper theorization in innovation process and the path dependency in the policy community, the early model of innovation policy (till 1990s), namely linear model, was an altered model originated from science and technology policy. It mainly focuses on financial provision to direct innovation producers, building R&D infrastructure and other support from a supply side of innovation input. The linear model of innovation policy has been criticized on its

lop-sided understanding of innovation process. Clearly, innovation in science, technology and service is a result of broader social and economic progress, and facilitating such process can not be adequately done by increasing direct innovation input. The demand side in a system of innovation and the absorptive capacity of the receivers are also needed to be equally taken into account in this model (Cohen and Levinthal, 1990; Edquist and Hommen, 1999). Further, interaction between organizations in a system of innovation, one important element in innovating, is often neglected as well in the linear model.

Currently, an emerging trend in innovation policy making is being witnessed. One might relate this trend to a systemic model. While the systemic model in innovation policy has been widely discussed in academia (Edquist, 1997; Smits and Kuhlmann, 2004), an explicit definition of such approach is not yet available. Nevertheless, a few characteristics of the systemic model can be identified as follow. Firstly, with respect to orientation of innovation policy, it should be a communicative (or interactive) process, meaning stakeholders of regional innovation policy, such as policy makers, implementers, innovation producers, innovation users, intermediaries should all involve in identifying their demands, and in what should be intervened and supported by policy instruments (Nauwelaers and Wintjes, 2003). Secondly, it should be systematic in the sense that innovation policy itself can be seen as a policy system that integrate a number of separated and often isolated policies into one unified frame (Chaminade and Edquist, 2006). In such an innovation policy system, systemic instruments are needed to address the system's demand which can not be fulfilled by

independent policy instruments (Smits and Kuhlmann, 2004). Also, to avoid contradiction that might be resulted from different innovation policies dealing with various areas and perspectives in a system of innovation, policy makers should keep these policies coherent (Christensen et al., 2003). Thirdly, a systemic model should be theoretically supported by existing theories focus on regional innovation study, such as system of innovation, knowledge based clusters (Cooke, 2002), knowledge spillover (Audretsch and Feldman, 1996; Bottazzi and Peri, 2003), learning region (Asheim, 1996; Florida, 1995; Morgan, 1997; Mackinnon et al., 2002), etc. These theories offer numerous rationales, perspectives, conceptual models that are of great value to policy makers.

4.2 Innovation study of developing world

Since late 1990s, innovation gradually becomes a buzzword in economic development literature concerning developing world, as discussed in the section 1, innovation is seen as key to economic growth and competitiveness at firm, region, country level. A number of reports have been produced, from a system of innovation perspective, on developing economies around the world. To name few, Tidd and Brocklehurst (1999) assessed Malaysia's innovation policy and performance, Solleiro and Castanon (2005) analyzed innovation system of Mexico, Intarakumnerd et al. (2002) presented an unsuccessful catching-up case of Thailand, Vonortas (2002) reported innovation system in some Latin American countries, Rooks and Oerlemans (2005) investigated effectiveness of South Africa’s system of innovation, Huang et al.

(2004) depicted the framework of the Chinese innovation system, and Chaminade and Vang (2005) studied system of innovation of four regions in Asia, etc. In general, these studies offered insightful knowledge of the structure and constitution of these innovation systems, drawing on the notion of system of innovation. A remarkable characteristic commonly shared by these studies is that while the description of these innovation systems followed the system of innovation theory, the innovation policy implications were often not done in the same manner. With respect to the operationalization of innovation policy, two problems may hinder the application of these innovation policy implications.

The first one is that policy implications are often overly general, meaning no adequate level comprehension is attached with these implications, in other words, these implications seemed stemmed from the general impression rather than a throughout policy analysis backed by system of innovation theory. For instance, one frequently offered suggestion is that to promote the quality and quantity of human capital in R&D and in the whole work force in general (Huang et al., 2004; Rooks and Oerlemans, 2005; Solleiro and Castanon, 2005; Tidd and Brocklehurst, 1999). While this suggestion is relevant to innovation policy formulation for regions in developing world, it is a universal common sense in almost any areas concerning social development, let alone to achieve this goal is a long-term mission which hardly have immediate impact on a catching-up innovation system. To increase the financial support, especially venture capital, to the R&D projects is commonly seen in these policy suggestions as well (Rooks and Oerlemans, 2005; Solleiro and Castanon, 2005).

Last but not least, to form modern innovation policy and to build supporting organization and institution that facilitate the innovation process are suggest in most reports (Chaminade and Vang, 2005; Intarakumnerd et al., 2002; Solleiro and Castanon, 2005). Such implications seem that they are made out of direct comparison of the current innovation policy practice in developing and developed world, a thorough analysis based on innovation policy literature seems not included.

Another problem associated with these policy implications has to do with that they do not touch upon in-depth issues in innovation policy. However, these issues do not only apply to regions in developing world, but to all type of regions as well. Thus, these implications seemed failed to offer policy implications that based on the idiosyncrasies and unique demand of regions in developing world. For example, it's suggested that innovation policy should focused on developing indigenous knowledge base (Tidd and Brocklehurst, 1999); promoting the network of innovation producers and agencies (Solleiro and Castanon, 2005; Vonortas, 2002); decentralizing the policy formulation process (Chaminade and Vang, 2005) and shifting away from the linear model (as discussed above) to systemic model (Solleiro and Castanon, 2005). Even though some policy implications pointed out that innovation policy developing should start from the insightful analysis of region and industry specificity (Chaminade and Vang, 2005), which does take the regional characteristics into consideration, such implication is an application of "one size fits all" notion in innovation policy which fits various type of regions, including developed and developing (Todtling & Trippl, 2005).

In the following part, I argue that while the approaches associated with the systemic model of innovation policy could and should apply to regions in developing world, some distinguishing aspects should be clarified in this systemic approach, according to the idiosyncrasies of regions in developing world. In doing so, first, I try to clarify the general process of innovation policy making from a systemic perspective. Then, analysis is devoted to whether developing economies could be seen as systems of innovation. If not, then how to apply these systemic approaches to the innovation policy practice in these economies.

5. Innovation policy formulation

5.1 Problem solving based innovation policy making for developed regions

The innovation policy formulation process, in many ways, is a problem solving based process. The first argument is made in relation to system of innovation theory. Innovation process itself is path-dependent and context depending. Thus, "best-practice" of innovation policy can not be transformed from one system of innovation to another. Also, it's been a consensus that there is no ideal model for innovation policy design (Edquist, 2001; Lundvall and Borras, 2005; Todtling and Trippl, 2005). Then, how could policy makers or scholars start initiating innovation policy? Edquist (2001) argued that one preconditions of innovation policy making is that the market mechanism and capitalist actors must have failed to achieve the objectives formulated. In other words, there must be a problem (or problems) existed in the current system of innovation, and the problem (or problems) can only be solved

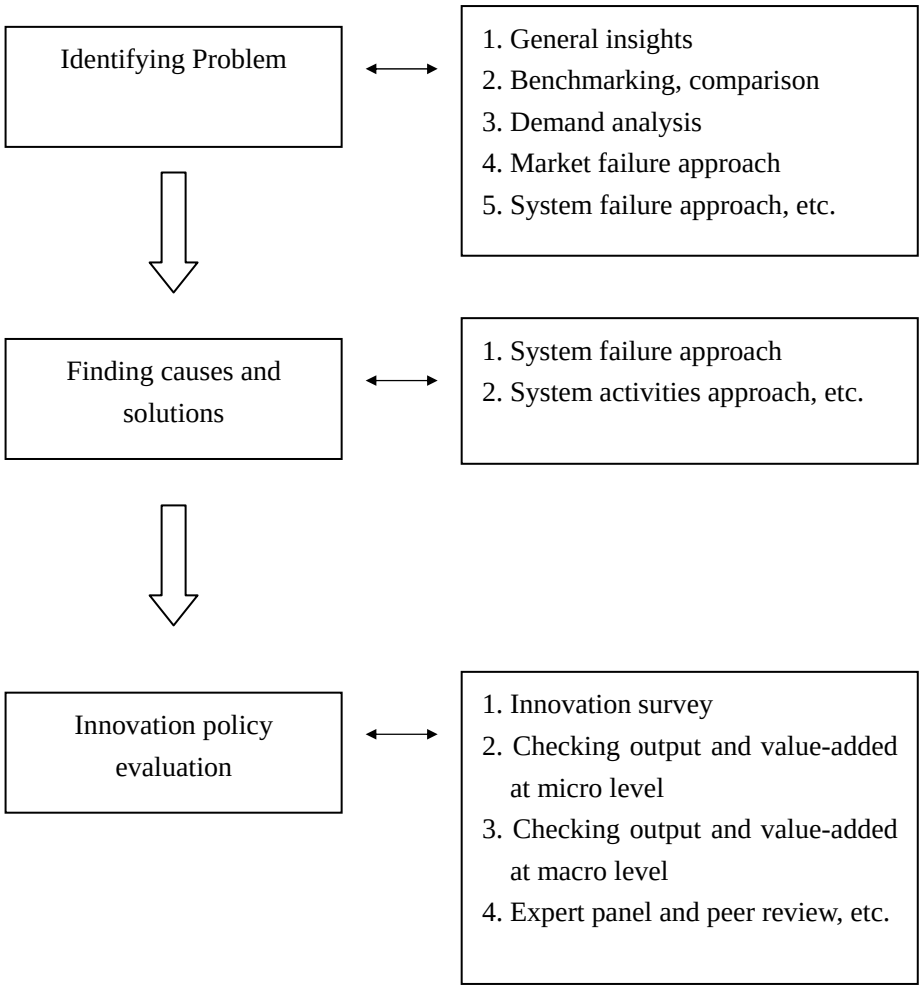
by new public actions other than the market mechanism and existing economic actors. Hence, the departure point for innovation policy making is identifying the problems existed in the current system of innovation. Despite these problems were not further specified by Edquist, in general, they could refer to problems recognized from system of innovation perspectives and problems in a more realistic sense in an economy (e.g. low competitiveness in certain industries or unemployment issues).

Secondly, the evolution of innovation policy indicates that it is made to solve the problems left by science and technology policy which have been existed in advanced economies for decades. Modern innovation policy in developed world, to some extent, seems to be derived from science and technology policy. Emerged in the post-war period, science policy was used by national authorities to strategically allocate national resources to tackle some vital scientific difficulties such as military program. The focuses of science policy are the establishment of universities, research institutions, technological institutes, and R&D laboratories, and the cooperation between them. Technology policy was developed and promoted during 1960s. While the objectives of technology policy are similar to those of science policy, technology policy focuses on developing and commercializing technologies and sectors. Innovation policy deals with the overall innovation performance and capacity in an economy. Its main objectives, among others, are economic growth and international competitiveness, (Lundvall and Borras, 2005). The evolution of science policy, technology policy and innovation policy is reflected on a number of reports (recommending economic policy for member countries) made by OECD, e.g. OECD

(1963) “Rationalizing science policy and linking it to economic growth”; OECD (1970) “Bringing in human and social considerations on technology policy”; and OECD (1980) “Innovation policy as an aspect of economic policy”. However, despite some countries followed the evolution path from science policy, technology policy to innovation policy, it is not a routine to understand the development of innovation policy as these policies overlapped and entangled in many ways (Borras, 2003).

As Lundvall and Borras (2005) classified, the elements and contents of innovation policy include (not only) those of science and technology policy. This implies that in the developed world the modern innovation system and innovation polices are built on the previous structure of science policy (initiated around 1950s) and technology policy (started in 1960s). In the developed world, innovation policy making did not started from scratch, rather, it adds new elements to the existing science and technology policy setting to facilitate and promote the innovation capacity. Borras (2003) described the design of European Commission innovation policy was based on the existing problems hindering innovation capacity of an economy, and the actual ability of public authority to solve these problems. These prerequisites of the innovation policy are in accordance to Eduqist’s advices (2001). At national level, Chaminade and Edquist (2006) documented that the one practical objective of the VINNOVA (The Swedish Agency for Innovation Systems) is the mismatch problem between the Sweden’s high investment on R&D and the relatively poor performance of product innovation.

Figure 1 Innovation policy making process for developed regions



Source: Evaluation part is based on Iturriagagoitia and Saez, (2006, March).

In this section, I discuss how the problem solving based innovation policy making process is carried out with existing approaches developed in association with system of innovation theory. As Figure 1 indicates, this problem solving process is divided into three stages, namely problem identification, causes and solutions finding, and policy evaluation.

5.11Problem identification

To identify the existing problems in a system of innovation, at least five approaches were suggested in previous researches. Firstly, Lundvall and Borras (2005) pointed out that the general insights of policy makers should be the prerequisites to

design a suitable innovation policy. Such insights may be derived from the familiarity of the system of innovation and general trainings in economics. Secondly, problems in a system of innovation can be found by benchmarking and by comparing the system to other systems of innovation (Eduqist, 2001; Nauwelaers and Wintjes, 2003). This is, as I discussed previously, because that there is no single optimal system model for different systems of innovation. Systems differ from each other in terms of the specialization on production, resource needed on R&D, and more importantly, the organizational and institutional setting. Thus, the only natural and vital means to tell one system's specialization and performance is to compare with other systems. The third approach is to analyze and gather demands from various innovation participants in a system of innovation to identify the problems. In principle, innovation policy can be classified as demand-side oriented and supply-side oriented. While the first two approaches aforementioned seem more relevant to the extent that a system of innovation can supply, to find those demands that have not been met in a system is an alternative way to define problems. According to Edler (2006, March), demand-side oriented innovation policy is "a set of public measures to induce innovations and/or speed up diffusion of innovations through increasing the demand for innovations, defining new functional requirement for products and services or better articulating demand." With respect to finding the problems in a system, this implies that, on the one hand, articulating and facilitating the demands of various innovation organizations e.g. demand for resources (finance, tax reduction, employee training, etc.); On the other, the state demand such as public procurement could be used to

promote the innovation activities in a system, especially for innovations at early stage (Chaminade and Edquist, 2006). The last two approaches are the aforementioned market failure approach and system failure approach (see section 3.2 and 3.3). Both focus on problems in an economy from market mechanism perspective and system of innovation theory point of view respectively.

5.12Finding causes and solutions

Perhaps the most vital step in innovation policy formulation is to pinpoint the causes of problems existed in a system of innovation and further to provide solutions accordingly. These seemed to be difficulty tasks in the early stage of system of innovation research, as the “black box” of innovation process has to be opened and analyzed before commencing the tasks. Up to the present, at least two approaches are instructive in providing conceptual framework to find the causes of problems and solution, namely system failure approach and system activities approach (as Figure 1 indicates).

Firstly, from system failure perspective, as I discussed, what could potentially go wrong in a system can be classified as organization, institution, the interaction between organizations, the interaction between institutions, the interaction between organization and institution, and finally the system itself constitute the last potential layer where failure could take place. Thus, solutions should be made according to these different types of problems. In short, these solutions could be public actions in:

1. Providing resources (e.g. financial resources) to incompetent organizations.

2. Setting up technology center or other plat form to broaden and deepen the knowledge diffusion channel.

3. Initiating R&D projects to facilitate the alliance between knowledge users and producers.

4. Increasing the innovation human resources base and mobility.

5. Strengthening the existing institutions or come up with new institutions.

6. Raising the innovation awareness among organizations in a system.

7. Directly establishing innovation centers to promote the innovativeness at the system level; etc.

Secondly, Chaminade and Edquist (2005) verified ten important activities in operation of a system of innovation. By opening the "black box" of innovation and reinforcing these important activities, the innovativeness of a system of innovation could be strengthened. According to them, the main activities in the system of innovation relate to the provision of knowledge inputs to the innovation process, the demand-side factors, the provision of constituents of system of innovation, and the provision of support services for innovating firms.

Provision of knowledge inputs to the innovation process

1. Provision of research and development (R&D) creating new knowledge, mainly in basic scientific research.

2. Competence-building (provision of education and training, creation of human capital, production and reproduction of skills, individual learning) in the labor force to be used in innovation and R&D activities.

Provision of markets – demand-side factors

3. Formation of new product markets.

4. Articulation of quality requirements emanating from the demand side with regard to new products.

Provision of constituents for system of innovation

5. Creating and changing organizations needed for the development of new fields of innovation, for example, enhancing entrepreneurship to create new firms and entrepreneurship to diversify existing firms, creating new research organizations, policy agencies, etc.

6. Provision (creation, change, abolition) of institutions – for example, IPR (Intellectual Property Rights) laws, tax laws, environment and safety regulations, R&D investment routines, etc – that influence innovating organizations and innovation processes by providing incentives or obstacles to innovation.

7. Networking through markets and other mechanisms, including interactive learning between different organizations (potentially) involved in the innovation processes. This implies integrating new knowledge elements developed in different spheres of the SI and coming from outside with elements already available in the innovating firms.

Support services for innovation firms

8. Incubating activities, for example, providing access to facilities, administrative support, etc. for new innovating efforts.

9. Financing of innovation processes and other activities that can facilitate

commercialization of knowledge and its adoption.

10. Provision of consultancy services of relevance for innovation processes, for example, technology transfer, commercial information and legal advice.

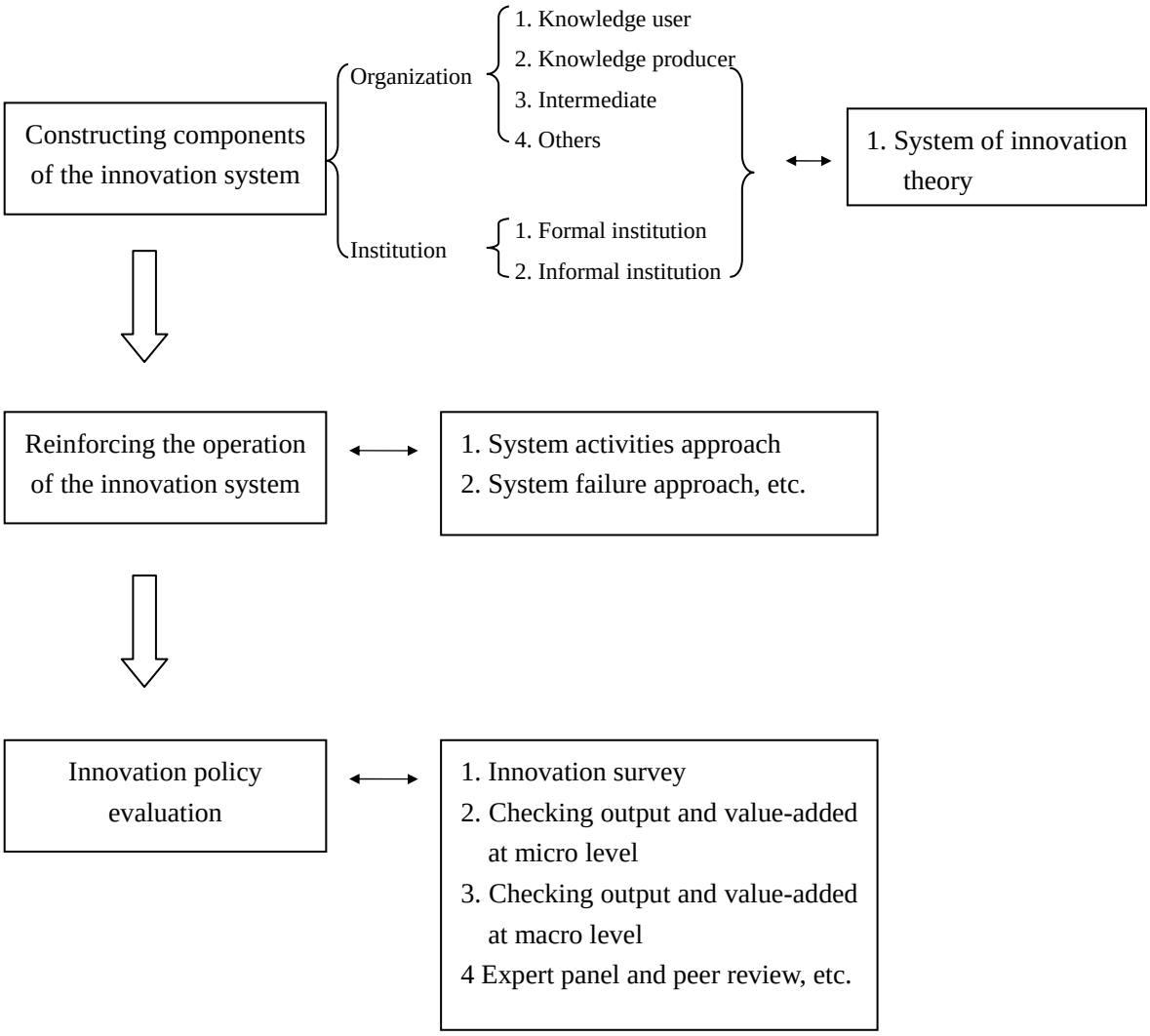
These two approaches analyzed the structure and operation of a system of innovation, thus, they can be applied as conceptual frameworks for formulating tangible innovation policy instruments in practice. The solutions based on system failure approach and the activities presented in system activities approach could serve as entry points for concrete policy making. Different systems of innovation may selectively apply these instruments into their specific regional context.

5.13Policy evaluation

With respect to policy evaluation, a number of approaches are used currently. According to a recent review (Iturriagagoitia and Saez, 2006, March), some commonly used approaches include innovation survey which assess the new job creation, new products and processes, increase in patents, etc. in specific sectors; micro methods which investigate firm competitiveness and other data at micro level; macro methods which assess the changes in R&D capital, human capital, regional employment, etc.; and expert panels or peer review which focuses on more qualitative assessment of the object.

5.2Constructing innovation system in developing world

Figure 2 Innovation policy making process for developing regions



Source: Evaluation part is based on Iturriagagoitia and Saez, (2006, March).

Innovation policy study for regions in developing world in comparison to the study for regions in developed world is relatively weak. As innovation means creating of new products, organizations and processes, much of the research attentions were attracted by more successful regional economies such as Silicon Valley in the U.S., Baden –Wurttemberg in Germany and Emilia-Romagna in Italy, etc. Even though the research inquiry does not merely concern these winner regions, other types of regions are taken into considerations as well, for instance old industrial regions (Todtling, 1992), peripheral regions (Feldman, 1994), etc. Nevertheless, much of the innovation

policy study are derived from investigation of these more advanced regions, which makes it doubtable to apply the results of these studies to the regions in developing world. As such, I argue that the problem solving based innovation policy process (or mentality) is not best suited for regions in developing world. A more efficient policy making process should be based on the characteristics of these regions, and to address these regions' demands.

To start designing innovation policy for a regional economy from the system of innovation perspective, the very departure point is whether the region in question could be considered as a regional system of innovation. The definition of regional system of innovation varies according to different authors or school of thoughts. While these definitions succeeded in describing regional system of innovation, they did not give explicit standard to verify whether a region could be seen as a regional system of innovation. It may be caused by the fact that most regions under investigation are located in the developed world. While these regions are not optimally functioning, most of them possess major elements and valid relationships between these elements which are indispensable for a regional system of innovation (Chaminade and Edquist, 2005). According to Asheim and Gertler (2005), a regional system of innovation could promote systemic relationships between firms and regional knowledge infrastructure to facilitate the "sticky" regional knowledge base and localized interactive learning. In addition, these systemic relationships must involve certain degree of interdependence and be regionally contained by the regional technology and knowledge bases. Thus, based on previous elaboration, a qualified

regional innovation system should at least contains the following;

1. Organizations including knowledge producers, diffusion agencies, final users;

2. Institutions with a clear focus to promote innovation;

3. Systemic relationship between these organizations and institutions;

4. Regional knowledge and technology base;

5. Regional interactive learning between organizations;

6. Regional culture, more or less, supporting innovating; etc.

If regions in developing countries, in general, have these characteristics of regional system of innovation, then the problem solving based method would apply to these regions. Previous investigation on the status quo of some developing economies can be indicative in verifying the applicability of this method. Some common characteristics of developing economics in relation to system of innovation are presented as follow;

1. Lack of R&D organization (Tidd and Brocklehurst, 1999), lack of general and knowledge infrastructure (Vonortas, 2002).

2. Lack of hard institutions, e.g. regulations encouraging innovation activities, tax reduction (Solleiro and Castanon, 2005), fragmented regulations (Rooks and Oerlemans, 2005), or conflicting institutions (Vonortas, 2002).

3. Lack of soft institutions, e.g. culture support for entrepreneurial (Solleiro and Castanon, 2005).

4. Lack of linkages between knowledge producers and users (Solleiro and Castanon, 2005).

5. Lack of infrastructure (Arocena and Sutz, 2000; Intarakumnerd, Chairatana and Tangchitpiboon, 2002).

6. Lack of interactive activities between innovation actors (Arocena and Sutz, 2000)

7. Lack of financial support for direct R&D (Arocena and Sutz, 2000; Intarakumnerd, Chairatana and Tangchitpiboon, 2002; Rooks and Oerlemans, 2005; Solleiro and Castanon, 2005).

8. Lack of innovation human resources and relevant training (Arocena and Sutz, 2000; Huang et al., 2004; Rooks and Oerlemans, 2005; Solleiro and Castanon, 2005; Tidd and Brocklehurst, 1999; Vonortas, 2002).

9. Lack of basic managerial skills, e.g. administration, marking, finance (Intarakumnerd, Chairatana and Tangchitpiboon, 2002; Rooks and Oerlemans, 2005; Solleiro and Castanon, 2005).

Having articulated the common weaknesses of these developing economies, one might find that in general developing economies lack of basic components (e.g. various innovation organizations, institutions, innovation personnel, innovation infrastructure, etc.) and relations (e.g. interdependences between organizations, interactive learning between peers, etc.) in system of innovation, so do the regions in these developing economies. As Arocena and Sutz (1999), and Gu (1999) both argued that, in contrast to the “ex post” phenomenon of system of innovation in developed world, system of innovation for developing world is an “ex ante” concept. The organizations, institutions and relations in developing economies usually do not function in a way described in system of innovation theory. Thus, I argue that the

departure point of innovation policy formulation for regions in developing world should be building these necessary ingredients (organizations, institutions, proper relations, etc.) of a system of innovation.

As Figure 2 indicates, to start a more suited innovation policy making process for regions in developing world, the first step is to proactively ensure the existence of ingredients of a system of innovation. When some ingredients are not available yet, authorities need to establish them according to the regional specific context by means of direct public intervention or collaboration between public and private sectors, so as to have a basic structure of a system of innovation. When this is done, secondly, authorities could use the conceptual frameworks (e.g. system failure approach, system activities approach, etc.) to examine and reinforce the operation of the regional system of innovation. By doing so, authorities could ensure that the regional economy functions in a systemically appreciated way.

When the basic structure and necessary operations of a regional system of innovation is guaranteed, the authorities of regions in developing world could start identifying the problems in the regional system of innovation, by applying the problem solving based process.

To conclude, in this section, I firstly argued that the common innovation policy making process for developed regions is problem solving based, due to the evolution of the innovation policy and innovation policy study, and the status quo of social and economic development in these regions. I then verified how various systemic

approaches can be applied in different stages, namely problem identification, finding causes and solutions, and evaluation the solutions, of this process. At the problem identification stage, several systemic approaches such as Benchmarking, comparison, demand analysis, market failure approach, system failure approach etc, could serve as the departure point to investigate what need to be done to improve the function of the regional system of innovation in question. At the causes and solution finding stage, two approaches, namely system failure approach and system activities approach, are highlighted as conceptual frameworks to diagnose a regional system of innovation. These conceptual frameworks drawing on the system of innovation insights offered by academic research, to bring about sensible policy instruments by opening the "black box" of the internal operation of a regional system of innovation. In the final stage of evaluating the innovation policy, tools such as innovation survey, checking output and value-added at micro level, checking output and value-added at macro level, expert panel and peer review, etc., are all of great value to accumulate fruitful experience in innovation policy making.

Secondly, due to the underdeveloped economic conditions of regions in developing world, I argue that these regions, to some extent, are not viable regional systems of innovation yet. Drawing on the system of innovation literature, a qualified regional innovation system should at least contains some recognizable characteristics such as, organizations including knowledge producers, diffusion agencies, final users; institutions with a clear focus to promote innovation; systemic relationship between these organizations and institutions; regional knowledge and technology base;

regional interactive learning between organizations; regional culture, more or less, supporting innovating; etc. Previous research investigation on regions in developing world showed that most regions surveyed lack quite a few these basic ingredients. Thus, the problems solving based process may not be applied to regions in developing country without proper alteration. To solve this problem, I proposed that innovation policy practice for these regions should start with building the necessary ingredients of a system of innovation. Then, drawing on the conceptual framework concerning how a system could properly function, regional authorities should reinforce the regional system of innovation which is actively constructed through the endeavor of the first step.

Next, I will present a case of innovation policy practice in a developing region, namely Zhejiang province in China, to justify the importance of following this particular process of innovation policy making and applying various systemic approaches induced from innovation study and innovation policy practice in the west.

6. Case of Zhejiang, China

6.1 Methodology

Case study

As stated repeatedly, innovation policy is highly region-specific in nature; it would be wise not to compare innovation policy between regions with different social-economic contexts. To understand innovation policy demands for a given region, familiarity of the regional economy and general insights of the existing

development of innovation organizations and institutions in the region is a must. To achieve this, some lengthy investigations are necessary. Thus, carrying out a case study should be a proper means to empirically justify the utility of the proposed innovation policy making process in section 5.

Research object

The region of Zhejiang is chosen as the case of enquiry is based on the following reasons; firstly, it is located in a typical developing country, China, and it is one of the most dynamic regional economies in the country (economy ranked 4th among all the regions). Secondly, the uneven economic development of the sub-regions in Zhejiang makes it a typical sample of regions in developing world. Thirdly, after the rapid economic growth in the last two decades (the annual economic growth in Zhejiang was above 15 % in the last two decade), it seems that the current model of economic growth which is based on mass production and labor intensive industries comes to a bottleneck. The regional economy is on the edge of turning from productivity driven to knowledge driven. Therefore, constructing innovation capacity becomes the major task for the regional authority. Fourthly, since few years ago, quite a large number of public policy regarding the innovation issues in the regions have been developed and implemented. Innovation thus has been a buzzword among the policy makers and public media. These could be taken as resources for the empirical investigation on innovation policy in Zhejiang.

Research protocol

1. General survey of the regional economy. This includes general information of the

GDP, regional industries, the openness of the economy, etc.

2. Highlighting the regional technology indicators, such as the education level of work population, R&D expenditures, etc.

3. Introduction of the development of regional innovation organization, e.g. university, research institutes, technology intermediate, etc.

4. Depiction of the current development of regional innovation policies, such as introduction of the government departments responsible for innovation policy making, the macro objectives of the regional innovation policies, and of course the main content of the regional innovation policies.

5. Analysis of the regional innovation policies using the policy making model developed in section 4 and 5. The first step is to verify whether the region of Zhejiang could be deemed as a regional system of innovation. It is measured by the necessary ingredients of a valid regional system of innovation (section 5). Then, I use the problem solving process developed in section 4 to check whether there are some important steps are missing in the innovation policy making process in Zhejiang.

The purpose of the case study is to indicate that, firstly, innovation policy making in developing regions should start from checking the existence of basic ingredients of a valid regional system of innovation, if these ingredients are not in place yet, the policy makers should focus on building these indispensable elements by applying system of innovation concepts. Secondly, when the first step is done, the problem solving based policy making process needs to be taken to ensure the completeness and logic in the innovation policy.

6.2The economy

Land, population and GDP

Zhejiang is a province in the southern part of the Yangtze River Delta on the southeast coast of China. By the end of 2005, its population reached 48.98 million. The province covers a total land of 101,800 square kilometers of which 59.4% are forestry. This region has rich non-metallic mineral reserves such as stone coal, alum, and tuff. As one of the most dynamic and economically developed provinces in China, Zhejiang ranked the fourth on the economic volume in the country. In 2005, the GDP of Zhejiang was 1336.5 billion RMB[1], with an increase of 12.4% over the previous year. The per capita GDP of the province was 27552 RMB, with an increase of 10.8% over the last year.

Regional industries

The textile is one of the main industries in Zhejiang province; its output and the exports capacity rank the first in China. The machinery manufacturing is the largest industry in terms of economic turnover, and it is the third in the country. The main products include air separation equipment, special industry steam turbines, electric dust catchers, pneumatic ash devices, etc. Zhejiang also has the largest crude oil processing base, and fluorine chemical industry base in China. In 2005, 145.45 billion RMB were invested in the real estate development. As one of the most attracting tourist destinations, in 2005 the income from domestic tourism was 124.0 billion RMB, with an annual increase of 22.4%. Last year alone, 127.58 million domestic

[1] The present exchange rate between US dollar and RMB is approximately 7.8. However, one RMB has the PPP (Purchasing Power Parity) value of 0, 56 US dollar in 2003 (The World Bank, 2005).

tourists had visited Zhejiang.

Export and import

As Table 1 indicates, in 2005, the total volume of import/export trading reached $107.4 billion, gaining a growth of 26.0% over the last year. Among which, $76.8 billion products and services were exported, with an annual growth of 32.1%; $30.6 billion products and services were imported, with an annual growth of 13.0%. The scale of import/export ranks the fifth among the provinces and provincial level cities directly under the control of Chinese central government. The trade surplus last year was $41.66 billion, ranking the first in the country. The economic dependence rate of on the foreign trade was 64.7%; and on the export was 46.3%. As such, Zhejiang has been an active participant in globe economy. Table 2 listed five largest international trading partners of Zhejiang. In addition, the first 10 exported/imported commodities are outlined in Table 3.

Table 1 Foreign Trade, 2000-2005 (Unit: Million $)

	2000	2001	2002	2003	2004	2005
Export	194.44	229.77	294.18	416.03	581.60	768
Import	83.90	98.22	125.45	198.20	270.70	306

Source: Zhejiang Provincial Government Information Center, (2006).

Table 2 First Ten Countries and Regions for Export / Import in 2005 (2004) (Unit：10, 000 $)

Country (Export)	Value (Percentage)	Country (Import)	Value (Percentage)
USA	1612454 (20.99%)	Japan	565276 (18.48%)
Japan	750413 (9.77%)	South Korea	378536 (12.38%)
Germany	418155 (5.44%)	Taiwan	354739 (11.6%)
Hong Kong	277590 (3.61%)	USA	253630 (8.29%)
United Kingdom	255153 (3.32%)	Germany	141970 (4.64%)

Source: Derived from Zhejiang Provincial Government Information Center, (2006).

Table 3 First Ten Commodities for Export/Import in 2005 (2004) (Unit：10,000 US$)

Export		Import	
Machinery & Electronic Products	3026220	Machinery & Electronic Products	921641
Garments and Clothing Accessories	1331820	High Tech Products	460797
Textile Yarn, Woven Fabrics and Related Products	1111094	Steel	220144
High Tech Products	602046	Plastics of Primary Pattern	199187
Shoes	265632	Purified Acid	191549
Furniture and Parts Thereof	217502	Waste Copper	148808
Hand or Car Wireless Telephones	180387	Integrated Circuits and Microelectronic Module	134904
Plastic Products	156259	Ethylene Glycol	105719
Automatic Data Processing Facilities and the Components	142792	Automatic Data Processing facilities and the Components	80715
Auto Parts	121774	Iron Sand and Preparation Concentrates	75480

Source: Derived from Zhejiang Provincial Government Information Center, (2006).

Foreign investment

In 2005, 3396 foreign owned firms registered in Zhejiang, with $16.13 billion have been contracted and $7.72 billion have been invested. As of the end of 2005, 35.7 thousand foreign owned firms had invested $36.73 billion in various industries in Zhejiang. According to Economic & Trade Commission of Zhejiang, 76 fortune 500 companies have established branches in Zhejiang.

6.3 Technology indicators

According to the first survey of main economic data in Zhejiang province (Zhejiang Provincial Bureau of Statistics, 2005), by the end 2004 , 6419 companies[2] (or 15.5% of the total companies)carried out R&D activities in Zhejiang. As Table 5 shows, 11.6 billion RMB (1.03% of the GDP) were invested in R&D, of which 10.4

[2] In the survey, the companies were specified as all state owned companies, and private owned with annual turnover above 5 million RMB.

billion were devoted to new product development. In 2004, some 76,600 personnel including scientists and engineers were engaged in R&D activities. In the total R&D expenditure, 0.881 billions RMB were spent by industries, which accounted for 0.48% of the total industrial income. With respect to the specific industrial R&D investment, over 1 billion RMB were devoted to the telecommunication and computer sector. Three industries, namely pharmaceutical industry, specialized machinery manufacturing and telecommunication and computer industry, invested more than 1% of their total incomes on R&D. In 2004, 9849 patents were applied in Zhejiang, and 3758 were approved by the state bureau. In addition to the R&D expenditure, industries invested 34.31 billion RMB in technology upgrade, 2.07 billion RMB in importing technology, and 0.46 billion RMB in absorbing these technologies. The education level of working population is indicated in Table 4, and Table 5 provides other data regarding R&D e.g. research paper published, technology transfer value, etc. in Zhejiang.

Table 4 Education of working population

Education factor	Working population (Number in per 10,000 employees)
Master degree of above	5.56
Bachelor	78.24
Associate Bachelor degree	149.40
High school	424.23
Advanced certificate of technician	2.35
Standard certificate of technician	6.97
Licensed technician	157.67

Source: Zhejiang Provincial Bureau of Statistics, (2005).

Table 5 Data on R&D of 2004

Factors	Amount
People employed in R&D	10.8 (in per 100, 000 employees)
Total R&D expenditure	11.6 billion RMB

Total R&D expenditure (as % of GDP)	1.03%
Number of patent registered	3578
Research paper published in domestic journals	12927
Number of contract made on technology transfer market	39974
Total trading value of the technology transfer market	5.8 billion RMB
Growth in High-tech sectors (over last year)	22.78%

Source: China Science and Technology Statistics, (2005).

6.4 Innovation organizations

Universities

As of 2004, Zhejiang has 73 higher education institutions, including university, polytechnics, advanced vocational school. Some 583000 students were enrolled in these institutions, nearly one third of which were student of polytechnics and of advanced vocational schools. However, in comparison with the large number of university, the university R&D budget from government was merely 2 billion RMB.

Research institutes

According the first survey of main economic data in Zhejiang province (Zhejiang Provincial Bureau of Statistics, 2005), 145 public research institutes are lcated in Zhejiang. Among which, 21 institutes are at national level (meaning there are financed by central government); 40 institutes administratively belong to the provincial government; and the rest 84 are affiliated to different municipalities. Aside from that, there are also 374 corporate research institutes founded by industries in Zhejiang. Whereas these corporate research institutes were newly established, by the end of 2004, 1279 industrialization projects were accomplished by these private institutes.

Public Labs

Since 1991, Zhejiang has set 203 public labs in the fields of information technology, biotechnology, electronic-mechanics, chemistry and agriculture, etc. These include 30 national labs, 75 provincial labs, 52 university labs, and 46 research institutes labs.

Technology intermediates

It is reported, as of 2002, various level of governments in Zhejiang established 14 specialized industry parks and 32 incubators with a clear mission to create high-tech firms (Science and Technology Department of Zhejiang Province, 2003). In order to facilitate the technology transfer, 13 national productivity promotion centers and dozens of regional innovation service centers are recently founded. In all the sub-provincial regions, online platform of technology transfer was put in use since 2002. All of these are connected to the online technology transfer system set by Science and Technology Department of Zhejiang Province.

6.5 Regional innovation policies

At present, innovation has been a buzzword in China, both in political sphere and economic sphere. The Chinese central government starts treating the national innovation capacity as the priority in economic and social development in general. In 2006, the state council released “National mid/long-term science and technology development planning report, 2006-2020” to consolidate the role of innovation in present China. This report sets the mission statement as that “We must strengthen our responsibility and sense of urgency, to actively and firmly take the technology progress as the primary driving force of social-economic development; to place the strengthening of independent (national) innovation capacity in the center of adjusting

economic structure, changing economic growth pattern, increasing national competitiveness; to make the building of innovative nation as a fatal strategic decision to confront the future challenge…. ” (Chinese State Council, 2006). The Zhejiang province as a regional authority, since then, has established a number of policies to promote the regional innovativeness.

6.51The process of policy formulating

Despite many innovation policies are initiated at national level[3], a sizeable portion of innovation policies are set at provincial level. The General Office of Provincial Government and the Department of Science and Technology are mainly responsible for designing and coordinating regional innovation policy, with support from other departments of the provincial government under specific circumstances. While the General Office of Provincial Government mainly sets the macro objectives of the innovation policies, the Department of Science and Technology deals with most of the innovation design. Several offices of this department are heavily involved into the innovation policy formulation, such as policy and regulation office, general planning office, high-tech and commercialization office, and technology marketing office, etc. Each office has 5-8 full time personnel to carry out the daily operation. The department has a number of subordinates in each city in Zhejiang. In addition, the Bureau of Intellectual Property is affiliated to this department. In general, innovation policy formulation is the collective work of these various offices with the final

[3] For a thorough description of national innovation formulation process, see Huang et al., (2004).

approval from the General Office of Provincial Government. However, the policy formulation process is, in a western standard, highly top-down. To a great extent it reflects the opinion of the provincial government rather than the industrial demands. One characteristic of the policy making is that, due to the traditional tie in the planned economic period, the department seems to mainly communicate with state owned firms. Another characteristic in the innovation management of Zhejiang province is that, public financed innovation projects are directed by Economic and Trade Commission, another department of the provincial government, due to the traditional governance pattern, and the different budgets each department acquires.

6.52The objectives of the innovation policy in Zhejiang

The general objective of innovation policy is in accordance with the national innovation policy as I introduced above. However, there are more tangible objectives raised in the government report on innovation (Science and Technology Department of Zhejiang Province, 2003). These objectives have been set for two periods of time. The first one is short-term, from 2003 to 2007. It is planned that, by the end of 2007 R&D expenditures should exceed 1% of the provincial GDP (this is done in 2005). There must be 60 R&D personnel in per 10,000 working people. The high-tech industries should account for at least 15% of the total regional GDP. Technology progress should at least contribute 50% of the total economic growth. The regional innovation system of Zhejiang should be based on the market mechanism and scientific social development principles. The second period is till end of 2020, by then

the R&D spending should exceed 2% of the regional GDP. Every 10,000 working people must contain at least 150 R&D personnel. The high-tech sector should account for at least 30% of the regional GDP. In short, by end of 2020, these specific indications of a system of innovation should be close to those of a advanced economy.

6.53Content of innovation policy

The innovation policies of Zhejiang (since later 1990s) include a wide range of instruments; cover most spheres of this regional economy. I then highlight some policies that have been designed and implemented for a few years since late 1990s.

Public expenditures on R&D

Since 1996, the provincial government incorporated the R&D expenditure requirement into the performance evaluation of leadership at each level of government. By this requirement, by the end of 2005, R&D expenditure should account for 7.8% of the total government budget at provincial level, 4% at the city level, and 3% at the county level. Officials who don’t meet these requirements would be removed from office.

Privatization of the public research institutes

The public research institutes originated from the planned economy before the economic reform in early 1980s. In many ways, they are not suited for current social demand for technology innovation, due to its managerial style, and incentive mechanism. Therefore, since 1997 the government has launched privatization project aiming to transform these research institutes into corporations. Individuals and private

firms, as well as other entities are allowed to acquire shares of these institutes, while the government in many cases remains its role as the decisive shareholder. The consequence is positive, the total income of these research institutes in 2003 increased 28.2% over the last year (Science and Technology Department of Zhejiang Province, 2003).

Dynamic rewarding policies

Since 2002, the government has changed the regulation of the rewarding mechanism to researchers employed by public institutions, such as university, research lab, etc. The new regulation is friendlier to researchers in many ways. For instance, researchers are entitled at least 20% shares of the commercialization projects initiated by their innovation.

Constructing technology transfer market

An online technology transfer system was established since 2002, as the first one of its kind in the country. By the end of 2003, 50,000 regional firms and more than 30,000 various universities and research labs cross the country have been enrolled in this system. And the total value of the traded technology since the start of this platform amounted to 2.84 billion RMB. In addition, one of the basic goals set by the Science and Technology Department of Zhejiang Province is to have 100 regional technology innovation service centers before 2007. Up to end of 2003, 25 such centers have started operating in various industries such as fishery, textile, and machinery.

Venture capital

Other than the public budget for R&D, the government has attracted some 40

venture capitals to open business in Zhejiang. In the end of 2003, these venture capitals invested more than 1 billion RMB on some 300 High-tech projects in Zhejiang.

Initiating R&D projects

Two major types of R&D projects have been conducted since 1999, namely vital industrialization of high-tech project and “star” projects. While the former normally involves tens of million for each project, the latter concentrated on high-tech start-ups. In 2003 alone, 75 firms graduated from “star” projects. In total, these graduates created some 5,500 jobs in the region.

Open biding for R&D projects

Traditionally, science and technology research projects were carried out by public institutions, such as university, public lab. Since 2001, the provincial government opened the changes for private research institutes. By the end of 2003, 164 such projects selected contractor through an open competition process. This facilitated the alliance between innovation organizations with different ownership.

6.6 Innovation policy analysis

Indeed, the innovation policies of Zhejiang cover a wide range of aspects in regional economy, however the innovation policy making in Zhejiang is not yet a systemic process. From the system of innovation theory perspective and the policy formulation process discussed in previous section, a number of criticisms can be made. They are presented in the following.

First and foremost, although the innovation policies seem to be an all-included package, they are still made by a problem solving based process. Each policy instrument is made to tackle specific realistic problems in the economy. Such rationale is discussed in most of the innovation reports made by Science and Technology Department. Thus, some important ingredients are still not included by these innovation policies. For instance, the interactive learning between organizations is not even mentioned in all the innovation reports. So far, no organization or institution has been established to facilitate the dynamic interaction between organizations. Another example is that while the policies have paid some attentions to the absorptive capacity of industries where mid and large sized firms are major participants; industries made by small sized firms are generally ignored, such as fashion, toy, furniture, shoe making industry, etc., which employ a big portion of the working population. Thus, if the innovation policy making is not started from the building necessary components of a system of innovation based on system of innovation theory, even a careful policy making process will neglect a number of important components.

Secondly and most surprisingly, since late 1990s the Zhejiang government started designing and implementing innovation polices, it has not conducted sufficient evaluation of these policy instruments (apparently, it is not mentioned in any innovation reports). It might be that to some extent, all the policy instruments are somehow effective in a fast growing economy like Zhejiang. However, it’s also hard to access how many resources have been wasted since late 1990s.

In addition, the rationales of innovation policy making are not sufficiently

discussed, let alone the examination of the rationales. For example, the uneven social and economic development is a serious problem in Zhejiang. The differences in economic structure and GNP are evident between the metropolitan areas like the capital city and remote cities. However, there differences are not yet addressed in the innovation policies. The objectives and design guidelines provided by Science and Technology Department ignores these regional disparities.

In short, the innovation policy practice in Zhejiang provides vivid case regarding the innovation policy of regions in developing world. On the one hand, ambitious regional government actively promotes the regional innovativeness by working on a wide range of innovation policy instruments. To some extent, the results are sound as the booming economy shows. On the other, these innovation policy practices lack of systemic approach in making and implementing, such as the innovation making process starting from building necessary components and relations, and various approaches in each stage of policy making. This made the innovation practice in regions in developing world less effective, and those obstacles previously existed may still hinder the innovation development in these regions.

7. Concluding remarks

As innovation policy studies pay less attention to regions in developing world, there is a need to fill the blank, in order to hone the efficiency and effectiveness of the innovation policies for there regions. In this thesis, I attempt to verify how to develop innovation policy for regions in developing world by applying the systemic

approaches and concepts. Accordingly, four sub questions are raised, which are justified respectively in the following sections. These questions concerns:

1. What is the link between innovation and regional economic development and growth? And why the innovation capability is crucial to regions?
2. Why innovation policy matters to regional innovation capacity building? To what extent the public policy intervention is significant to a regional innovation system?
3. What is the state-of-the-art innovation policy study from system of innovation theoretical perspective? How could one theoretically examine the common process of innovation policy making? This paradigm may include a. the departure point of innovation policy design; b. the conceptual frameworks to pinpoint the causes of failure and obstacles hindering the innovating process in a region, from the system of innovation perspective; c. the operational innovation policy instruments that could transform the diagnosis into tangible action; d: the evaluation of the policy instruments and the afterwards necessary revision.
4. What should be made differently, if one applies the abovementioned process of innovation policy making to the regions in developing world?

In section 2, I have verified the relevance between innovation and economic growth in various relevant economic theories and discourse. From historical point of view, innovation was the key elements in catching-up process of some later industrialized nations in 19th and 20th century. Innovation becomes more relevant to the current economic development, as the previous economic model based on mass production and productivity growth has given way to the knowledge based economic

growth which is now pursued by a good number of governments all round the world. As a proof, innovation and knowledge have been gaining firm roles in the neo-classical economic modeling. Thus, it is reasonable to conclude that firstly, innovation is now a key factor to economic growth. Secondly, as innovation is the major determinant factor for different rates in regional economic growth (Fagerberg, 1987), building innovative capacity should be a new focus in economic competition in world economy. While these conclusions are applicable to regions in developed world, they are also highly relevant to regions in developing world. As the technology transfer and diffusion in the frontiers become increasingly difficult, and exploitation of the existing technology will eventually come to an end.

In section 3, I have justified the rationales of public intervention in increasing and promoting innovativeness of an economy. Drawing on various theoretical perspectives e.g. politics, market operation, system of innovation theory, etc., I made four argument to verify the validity of public innovation policy. Firstly, if innovation is a key factor in economic growth and international competition, the government should engage in facilitating innovation activities in order to create and sustain the wealth in the society. Secondly, innovation could not be sufficiently created by free market mechanism, as three natures of knowledge, namely *uncertainty*, *inappropriability*, *indivisibility*, are contrary to the pursuit for profit. Thirdly, if one view regional economy from system of innovation theory perspective, there are a number of failures could take place at various components of a system, such as innovation organizations, institutions, and the system itself. Finally, without proper public intervention and

coordination, the much demanding sense-making process between innovation actors is not likely to occur sufficiently. Thus, innovation policy is vital to innovation capacity building, as satisfactory innovation performance is not a direct result of un-intervened functioning of a system of innovation.

In section 4, I firstly discussed the ongoing evolution in the field of innovation policy study. It is widely agreed that linear model policy making is giving way to a systemic model. Several essences of the systemic models are singled out. For instance, the communicative (or interactive) process of policy making; treating innovation policy itself as a policy system; the rationales of policy making should be supported by existing theories of innovation study. Some previous works on innovation policy and regional innovation performance in regions in developing countries are critically reviewed. Two problems are identified within these works. The first one is that policy implications are often overly general, they seemed stemmed from the general impression rather than a throughout policy analysis backed by system of innovation theory. The second problem is that these policy implications are overly general. The uniqueness of developing regions was not sufficiently taken into account.

In section 5, it is verified that the dynamic innovation policy research delivered a good number of systemic approaches and concepts in relation to innovation policy practice. However, as theoretically suggested (Edquist, 2001) and realistically practiced, these systemic approaches and concepts are applied in a problem solving based process. While this process may be suited for the current social-economic conditions shared by developing regions, it should not be assumed that for regions in

developing world this process can be taken for granted. It's simply because the system of innovation for most developing regions is an "ex ante" concept. Many necessary ingredients of a system of innovation are not yet established in developing regions. Thus, the problem solving based process seems to be fragmented to go with the underdeveloped social-economic conditions in developing regions where a slew of problems can be identified from theoretical and realistic sense. To solve this, I proposed that innovation policy practice for developing regions should start from building the necessary ingredients of a system of innovation. Then, drawing on the conceptual framework concerning how a system could properly function, regional authorities could reinforce the regional system of innovation which is actively constructed through the endeavor of the first step.

Granted, innovation policy practice is a fussy issue for developing regions, given the current state of their social-economic development, given the lack of relevant theory and relevant experience. Nevertheless, if the departure point of innovation policy making is to proactively ensure the existence of basic structure and ingredients of a system of innovation, the systemic approaches and concepts induced from innovation study and practice in the west are still of great importance to developing regions. As the case study of Zhejiang illustrated in section 6, the shortcoming of not firstly constructing the basic ingredients of a system of innovation and subsequently applying systemic approaches to the regional innovation policy making will cause many blind spots in the policy practice.

Reference

Acs, Z. (Eds.). (2000). *Regional innovation, knowledge and global change.* London: Pinter.

Arocena, R., & Sutz, J. (2000). Looking at national innovation systems from the South. *Industry and Innovation, 7,* 55–75.

Arrow, K. (1962). Economic welfare and the allocation of resources for invention. In R. Nelson (Eds.), *The rate and direction of inventive activity.* Princenton: Princenton University Press.

Asheim, B. T. (1996). Industrial districts as 'learning regions': A condition for prosperity. *European Planning Studies ,4,* 379-400.

Asheim, B. T., & Gertler, M. S. (2005). The geography of innovation: Regional innovation system. In J. Fagerberg, D. Mowery, & R. Nelson (Eds.), *The oxford handbook of innovation.* Oxford: Oxford University Press.

Audretsch, D., & Feldman, M. (1996). Knowledge spillovers and the geography of innovation and production. *American Economic Review, 86(3),* 630-640.

Autio, E. (1998). Evaluation of RTD in regional systems of innovation. *European Planning Studies, 6,* 131-140.

Borras, S. (2003). *The innovation policy of the European Union: From government to governance.* Cheltenham: Edward Elgar.

Bottazzi, L., & Peri, G. (2003). Innovation and spillovers in regions: Evidence from European patent data. *European Economic Review, 47,* 687-710.

Braczyk, H. J., Cooke, P., & Heidenreich, M. (Eds.). (1998). *Regional innovation systems.* London: UCL Press.

Breschi, S., & Malerba, F. (1997). Sectoral innovation systems: Technological regimes, Schumpeterian dynamics, and spatial boundaries. In C. Edquist (Eds.), *Systems of innovation: Technologies, institutions and organizations*. London: Pinter.

Carlsson, B. (Eds.). (1995). *Technological systems and economic performance: The case of factory automation.* Dordrecht: Kluwer.

Carlsson, B., & Jacobsson, S. (1997). In search of useful public policies: Key lessons and issues for policy makers. In B. Carlsson (Eds.), *Technological systems and*

industrial dynamics. Norwell and Dordrecht: Kluwer Academic Publishers.

Chaminade, C., & Edquist, C. (2005). *From Theory to Practice The Use of the Systems of Innovation Approach for Innovation Policy* (CIRCLE Electronic Working Paper Series No. 2). Lund, Sweden: Lund University, Centre for Innovation, Research and Competence in the Learning Economy.

Chaminade, C., & Edquist, C. (2006). *Rationales for public policy intervention from a system of innovation approach: The case of VINNOVA* (CIRCLE Electronic Working Paper Series No. 4). Lund, Sweden: Lund University, Centre for Innovation, Research and Competence in the Learning Economy.

Chaminade, C. & Vang, J. (2005). *Innovation policies for small and medium size enterprises in Asia: An innovation systems perspective* (CIRCLE Electronic Working Paper Series No. 6). Lund, Sweden: Lund University, Centre for Innovation, Research and Competence in the Learning Economy.

Chen, T. J., & Lee, J. S. (Eds.). (2004). *The knowledge economy of Taiwan.* Cheltenham: Edward Elgar.

Chinese State Council. (2006). National mid/long-term science and technology development planning report, 2006-2020. Beijing: Chinese State Council. (In Chinese)

Christensen, P. R., Cornett, A. P., & Philipsen, K. (2003). Coherence of innovation policy instruments. In B. Asheim, A. Isaksen, C. Nauwelaers, & F. Todtling (Eds.), *Regional innovation policy for small–medium enterprises.* Cheltenham: Edward Elgar.

Cohen, W., & Levinthal, D. (1990) Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35,* 128-152.

Cooke, P. (2001). Regional innovation systems, clusters, and the knowledge economy. *Industrial and Corporate Change, 10 (4),* 945-974.

Cooke, P. (2002). *Knowledge economies, clusters, learning and cooperative advantage.* London: Routledge.

Cooke, P., Boekholt, P., & Todtling, F. (2000). *The Governance of innovation in Europe.* London: Pinter.

Dahlman, C. J. & Anderson, T. (Eds.). (2001). *Korea and the knowledge-based economy.* Herndon, VA: World Bank Publication.

De la Mothe, J., & Paquet, G. (Eds.). (1998). *Local and regional systems of innovation.* Boston: Kluwer Academic Publishers.

Druckner, P. (1998). From capitalism to knowledge society. In D. Neef (Eds.), *The knowledge Economy.* Boston: Butterworth-Heinemann.

Eaton, J., & Kortum, S. (1999). International technology diffusion: Theory and measurement. *International Economic Review, 40,* 537-570.

Edler, J. (2006, March). Demand oriented innovation policy. Paper presented at International ProACT conference for Innovation Pressure - Rethinking Competitiveness, Policy and the Society in a Globalized Economy, Tampere, Finland.

Edquist, C. (1997). Systems of innovation approaches - Their emergence and characteristics. In C. Edquist (Eds.), *Systems of Innovation.* London: Pinter.

Edquist, C. (2001). Innovation policy - A systemic approach. In D. Archibugi & A. Lundvall (Eds.), *The globalizing learning economy.* Oxford: Oxford University Press.

Edquist, C., & Hommen, L. (1999). System of innovation: Theory and policy for the demand side. *Technology in Society, 21,* 63-79.

Edquist, C., & Johnson, B. (1997). Institutions and organizations in systems of innovation. In C. Edquist (Eds.), *Systems of innovation-Technologies, institutions and organizations.* London: Pinter.

Fagerberg, J. (1987). A technology gap approach to why growth rates differ. *Research Policy, 16,* 87-99.

Fagerberg, J., & Verspagen, B. (2001). Technology-gaps, innovation-diffusion and transformation: An evolutionary interpretation. *Research policy, 31,* 1291-1304.

Feldman, M. (1994). *The geography of innovation.* Boston: Kluwer Academic Publishers.

Florida, R. (1995). Toward the learning region. *Futures, 27(8),* 527-536.

Foray, D., & Kahin, B. (Eds.). (2006). *Advancing knowledge and the knowledge economy.* Cambridge: MIT Press.

Freeman, C. (1987). *Technology policy and economic performance: Lessons from Japan.* London: Pinter.

Freeman, C. (2002). Continental, national and sub-national innovation systems-Complementarity and economic growth. *Research Policy, 31,* 191-211.

Gustafsson, R., & Autio, E. (2006, March) Grounding for innovation policy: The market, system and social-cognitive failure rationales. Paper presented at International ProACT conference for Innovation Pressure - Rethinking Competitiveness, Policy and the Society in a Globalized Economy, Tampere, Finland.

Hadjimanolis, A., & Dickson, K. (2001). Development of national innovation policy in small development countries: *The case of Cyprus. Research Policy, 30,* 805-817.

Howells, J. (2005). Innovation and regional development: A matter of perspective? *Research Policy, 34,* 1220-1234.

Huang, C., Amorim, C., Spinoglio, M., Gouveia, B., & Medina, A. (2004). Organization, programme and structure: An analysis of the Chinese innovation policy framework. *R&D Management, 34(4),* 367-387.

Intarakumnerd, P., Chairatana, P., & Tangchitpiboon, T. (2002). National innovation system in less successful developing countries: *The case of Thailand. Research Policy; 31,* 1445-1457.

Iturriagagoitia, J. M. Z., & Saez, F, J. (2006, March). Regional science, technology and innovation policy evaluation: Approaches and methods. Paper presented at International ProACT conference for Innovation Pressure - Rethinking Competitiveness, Policy and the Society in a Globalized Economy, Tampere, Finland.

Justman, M., & Teubal, M. (1986). Innovation policy in an open economy: A normative framework for strategic and tactical issues. *Research Policy, 15,* 121-138.

Lagendijk, A. (2000). Learning in non-core regions: Towards 'Intelligent Clusters'; addressing business and regional needs. In F. Boekema, K. Morgan, S. Bakkers, & R. Rutten (Eds.), *Knowledge, innovation and economic growth.* Cheltenham: Edward Elga.

Lipsey, R. & K. Carlaw (1998). *A structuralist assessment of technology policies - Taking Schumpeter seriously on policy* (Industry Canada Research Publications Program No. 123). Ottawa, Ontario: Industry Canada.

Lundvall, B. A. (Eds.). (1992). *National systems of innovation: Towards a theory of*

innovation and interactive learning. London: Pinter.

Lundvall, B. A., & Borras, S. (2005). Science, technology, and innovation policy. In J. Fagerberg, D. Mowery, & R. Nelson (Eds.), *The oxford handbook of innovation.* Oxford: Oxford University Press.

Mackinnon, D., Cumbers, A., & Chapman, K. (2002). Learning, innovation and regional development: A critical appraisal of recent debates. Progress in Human Geography, 26(3), 293-311.

Malerba, F., & Orsenigo, L. (1997). Technological regimes and sectoral patterns of innovation activities. *Industrial and Corporate Change, 6,* 83-117.

Martin, S., & Scott, J. T. (2000). The nature of innovation market failure and the design of public support for private innovation. *Research Policy, 29,* 437-447.

Mokyr, J. (2002). *The gift of Athena: Historical origins of the knowledge of economy.* Princeton: Princeton University Press.

Morgan, K. (1997). The learning region: Institutions, innovation and regional renewal. *Regional Studies, 31,* 491-504

Nadiri, M. I. (1993). *Innovations and technological spillovers* (NBER Working Paper No. 4423). Cambridge, MA: National Bureau of Economic Research.

Nauwelaers, C., & Wintjes, R. (2003). Towards a new paradigma for innovation policy? In B. Asheim, A.Isaksen, C. Nauwelaers, & F. Todtling (Eds.), *Regional innovation policy for small–medium enterprises.* Cheltenham: Edward Elgar.

Nelson, R. R. (1959). The simple economics of basic scientific research. *Journal of Political Economy, 67,* 297-306.

Nelson, R. R. (Eds.). (1993). *National innovation systems - A comparative analysis.* Oxford: Oxford University Press.

Nelson, R.R., & Mowery, D. (Eds.). (1999). S*ources of industrial leadership: Studies of seven industries.* Cambridge: Cambridge University Press.

Niosi, J., Saviotti, P., Bellon, B., & Crow, M. (1993). National systems of innovation: In search of a workable concept. *Technology in Society, 15,* 207-227.

Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company.* Oxford: Oxford University Press.

OECD (1999). *The knowledge-based economy: A set of facts and figures.* Paris: OECD.

Pavitt, K., & Walker, W. (1976). Government policies towards industrial innovation: A review. *Research Policy, 5,* 11-97.

Rooks, G., & Oerlemans, L. (2005). South Africa: A rising star? Assessing the X-effectiveness of South Africa's national system of innovation. *European Planning Studies, 13(8),* 1205-1226.

Science and Technology Department of Zhejiang Province. (2003). Cultivating the subjects of innovation, strengthening the innovation capacity. Hangzhou, China: Science and Technology Department of Zhejiang Province. (In Chinese)

Science and Technology Department of Zhejiang Province. (2003). Zhejiang, building technologically advanced province: A report of creating a superior regional innovation system. Hangzhou, China: Science and Technology Department of Zhejiang Province. (In Chinese)

Smith, K. (1997). Economic infrastructures and innovation systems. In C. Edquist (Eds.), *Systems of innovation: Technologies, institutions and organizations.* London: Pinter.

Smith, K. (2000). Innovation as a systemic phenomenon: Rethinking the role of policy. *Enterprise & Innovation Management Studies, 1,* 73-103.

Smith, K. (2000, June). What is 'the knowledge economy'? Knowledge-intensive industries and distributed knowledge bases. Paper presented at the DRUID Summer Conference on 'The Learning Economy - Firms, Regions and Nation Specific Institutions', Aalborg, Denmark.

Smits, R., & Kuhlmann, S. (2004). The rise of systemic instruments in innovation policy. *International Journal of Foresight and Innovation Policy, 1,* 4-32.

Solleiro, J. L., & Castanon, R. (2005). Competitiveness and innovation systems: The challenges for Mexico's insertion in the global context. *Technovation, 25(9),* 1059-1070.

Solow, R. M. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics, 70,* 65-94.

Tan, K. S., & Phang, S. Y. (2005). *From efficiency-driven to innovation driven economic growth: Perspectives from Singapore* (World Bank Policy Research Working Paper No. 3569). Washington, DC: The World Bank.

The World Bank. (2005). The world bank development indicators. Washington, DC: The World Bank.

Tidd, J., & Brocklehurst, M. (1999). Routes to technological learning and development: An assessment of Malaysia's innovation policy and performance. *Technological Forecasting and Social Change, 62(3),* 239-257.

Todtling, F. (1992). Technological change at the regional level: The role of location, firm structure, and strategy. *Environment and Planning, A24,* 1565-1584.

Todtling, F., & Trippl, M. (2005). One size fits all? Towards a differentiated regional innovation policy approach. *Research Policy, 34,* 1203-1219.

Ulku, H. (2004). *R&D, innovation, and economic growth: An empirical analysis* (IMF Working paper No. 185). Washington, DC: International Monetary Fund.

Verspagen, B. (2005). Innovation and economic growth. In J. Fagerberg, D. C. Mowery & R. Nelson (Eds.), *The oxford handbook of innovation.* Oxford: Oxford University Press.

Viotti, E. B. (1997). *Passive and active national learning systems.* Doctoral Dissertation. New School for Social Research, New York.

Vonortas, N. S. (2002). Building competitive firms: Technology policy initiatives in Latin America. *Technology in Society, 24,* 433-459.

Watkins, A. (2003). *From knowledge to wealth: Transforming Russian science and technology for modern knowledge economy* (World Bank Policy Research Working Paper No. 2974). Washington, DC: The World Bank.

Wilson III, E. J. (2005). Trends in China’s transition towards a knowledge economy. *Journal of the University of California Press, 45(6),* 886-906.

Zhejiang Provincial Bureau of Statistics. (2005). The first survey of main economic data in Zhejiang province (No. 1). Hangzhou, China: Zhejiang Provincial Bureau of Statistics. (In Chinese)

Zhejiang Provincial Government Information Center. (2006). About Zhejiang. Retrieved Sep 5, 2006, from http://www.zhejiang.gov.cn