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Dirty history versus clean expectations: Can energy policies provide momentum for growth?

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ABSTRACT

We study the impact of economic policy on the importance of history and expectations for the macroeconomic performance of an economy. In our model the energy mix is based on the conversion of heterogeneous energy sources. Markups over marginal costs are endogenous so that the marginal revenue product of capital becomes non-monotonic in capital. We derive multiple steady states and identify regions in which initial conditions are insufficient as a selection criterion for development. In these situations, pure expectations determine the equilibrium selection process which is crucial for long-run performance. Energy policy affects the interplay between history and expectations by shifting the region where expectations matter and by affecting the location of the equilibria in the dirty and the clean economy. We find that taxes and subsidies should be used simultaneously to guide an energy transition. We argue that expectations and momentum effects are important for the energy transition because they decrease policy costs and thus raise political acceptance.

1. Introduction

1.1. Transforming the energy system

World energy supply relies heavily on the use of fossil fuels. The associated side effects of global warming as well as regional and local air and water pollution strongly suggest transforming current energy systems. This can be done by reducing energy use, increasing energy efficiency, and promoting renewable and cleaner energies. Based on the decisions of the UN climate conferences, all countries will have to contribute to solving the global climate problem by lowering their carbon emissions. The European Union has decided the target of cutting per capita carbon emissions by 40% in 2030 against 1990 levels. The presidents of China and the US recently announced their CO_2 abatement targets. For China it was stated that CO_2 emissions will peak in 2030 and that the share of non-fossil fuels in primary energy should be 20% by then. For the US it was announced that it intends to reduce its CO emissions by 26–28% below its 2005 level in 2025.

Air quality has increasingly become a cause of major concern in many emerging economies. Prominently, in cities like China's capital Beijing, the effects of the extreme levels of air pollution on daily life can increasingly be seen in the form of health problems, deserted bike lanes, and people often staying at home or retreating to conditioned environments of hermetically-sealed malls. Accordingly, the transition to a less polluting energy sector and a cleaner and more sustainable economy is high on the political agenda.

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But, what will be the impact of lower and cleaner energy use on the macroeconomic performance of an economy? Can appropriate policy help avoiding unfavorable income effects and how? There is a widespread public concern that energy and climate policies cause major costs. Then, efficient environmental policies in the form of Pigovian taxes or pollution permits are difficult to implement politically. More optimistic analyses have highlighted the positive impact of new energy technologies on general productivity and economic dynamics. Therefore, subsidies for renewable energies and active technology policies can be suitable alternatives or at least complements to taxes and permits. But subsidies have to be financed by public funds which compete with other public needs and duties. As a consequence, situations in which environmental policies cause limited costs but have strong impacts on emission reduction and income growth appear to be especially desirable. Are such cases realistic? The literature distinguishes between history and expectations as determinants of an equilibrium selection process. If past development ("history") determines the transition to a long-run equilibrium, a shift to a new steady state requires significant and potentially expensive policy interventions which might be hard to get approved by the political process. But if the equilibrium is determined by "expectations" of a cleaner future production, policy has only to be active in an initial phase. After that, induced investments may create speeding moments and policy-enforcing momentum might materialize. Hence, expectation-driven equilibria can support initial policy and lower the costs of the transformation of energy systems.

The paper at hand studies the macroeconomic effects of a policy-induced transition from dirty to clean production. Notably, we identify macroeconomic conditions under which expectations affect the trajectory chosen by market participants. We show how policy instruments are able to trigger development with sufficient momentum, fostering at the same time environmental quality, and increasing incomes. The cases in which long-run equilibria are driven by the history of production or by expectations are formally derived. Moreover, we study how economic policy affects the importance of expectations compared to history.

We present a generic macroeconomic model with capital accumulation and a detailed energy sector to study the interplay between policies and the multiplicity of equilibria. In the model, energy is not simply a homogeneous input but, closer to real conditions, an aggregate of heterogenous services. We derive how a policy promoting energy efficiency can, under certain conditions, generate broad momentum, moving an economy to a permanently higher activity and welfare level. This constitutes an especially attractive option for policy making.

1.2. Approach and findings

To analyze the transformation of the energy sector we assume that final output is produced by two types of intermediate input: dirty or clean. Dirty intermediates rely on capital and fossil energy services while clean intermediates employ capital and renewable energy services. Both intermediates are prefect substitutes and, initially, only the dirty sector is active.[1]

We incorporate a number of stylized facts into our model. First, the energy sectors feature characteristic elements of the industry. We assume that energy services are based on the conversion of heterogeneous energy sources like oil, coal, wind, solar, etc., which is done by specialized firms. Heterogeneity may result from specific attributes of each energy source, such as fixed costs, supply intermittency, back-up capacity, and pollution intensity or by the specific supply conditions of the different firms like tariff structure and reliability. As a consequence of these heterogeneities, both the quantity and the variety of energy services have a productive value. Second, because energy services are incomplete substitutes for each other, they are supplied under the market form of incomplete competition. Energy producers can charge a markup over marginal cost. In equilibrium with free market entry, monopoly profits are used to cover the fixed costs. Third, capital productivity is determined by the variety of energy services and economic policy. Moreover, capital is accumulated endogenously by investment decisions of the firms. Fourth, following the standard Ramsey–Cass–Koopmans model, returns to capital are decreasing in the capital stock. However, this useful and broadly used approach is not consistent with the empirical observations of lacking convergence in per capita income (Barro, 1991), the absence of large cross-country differences in interest rates, and the failure of capital to flow from rich to poor countries (Lucas, 1990). Moreover, it cannot explain the deficiency of real wages to develop in a countercyclical fashion and the decrease of the capital share in the course of economic development. This is why we add a second main contribution to our framework, which is to incorporate results on endogenous markups from the IO literature. Specifically, we rely on Rotemberg and Woodford (1991, 1995), who find that mark-ups interact with business formation, and Jaimovich (2007) and Jaimovich and Floetotto (2008) who analyze the interaction of markups with business cycles. Also, we build on the macroeconomic literature studying transitory behavior and the long-run performance of an economy using endogenous markups, see Gali (1994, 1995). Assuming that markups are endogenous and inversely related to the capital stock provides an attractive explanation for the different empirical observations mentioned above. Accordingly, we incorporate endogenous markups and thoroughly explore the impact of the assumption on the transformation of an economy from dirty to clean production. Fifth, to add another realistic element of capital accumulation, we posit that capital cannot be increased without any frictions, i.e. we include capital adjustment costs in the model.

As a consequence of endogenous markups, the marginal revenue product of capital may become non-monotonic in the capital stock. Hence, the possibility of multiple steady states and multiple equilibrium paths for given initial conditions

[1] It is a limiting case of a model with directed technical change where both technologies are active, which we consider to keep the model analytically and numerically tractable; a model version where both sectors are active simultaneously is available from the authors upon request.