How to view Structural Change: The Case of Economic Transition in Bulgaria

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The complex transformations, taking place in the post-communist countries are hard to scrutinize and appraise theoretically. One of the ways to summarize the changes is the input-output analysis of inter sectoral flows of a national economy. However, the possibility of understanding the final outcome of all alterations in the tables of inter sector flows is hampered by the extreme complexity of the data. In addition, even if we were able to immediately process all the numbers in the schedule, the question remains how to interpret them. A promising new method to immediately grasp both qualitative dimensions and theoretical meaning of complex data sets, are methods for the visualization of structures.

The latter is different from the usual in economical chart drawing. The visualization is a class of techniques that allows for multidimensional representation of manifold data series. The multiple dimensions effect is achieved by using features like colors, distances, forms, shapes, grouping of objects etc. .In the case of transition-generated economic evolution in Bulgaria, we used inter sector input-output flows evaluated in dollars. Our aim was not simply to illustrate the flows at different points of time, but to detect the emerging of a new, market-based economic order.

It is apparent, that the core of the economic reforms in the former centrally planned economies is the price liberalization. The decentralized relative price changes lead to direct shifts of the inter sectoral flows, that can be easily grasped, and to more complex indirect adjustments. According to economic theory, the price changes should lead to an economic equilibrium if some general suppositions are fulfilled. These conjectures usually comprise the so called hard budget constraints,Walras' Law, and further homogeneity and behavioral assumptions

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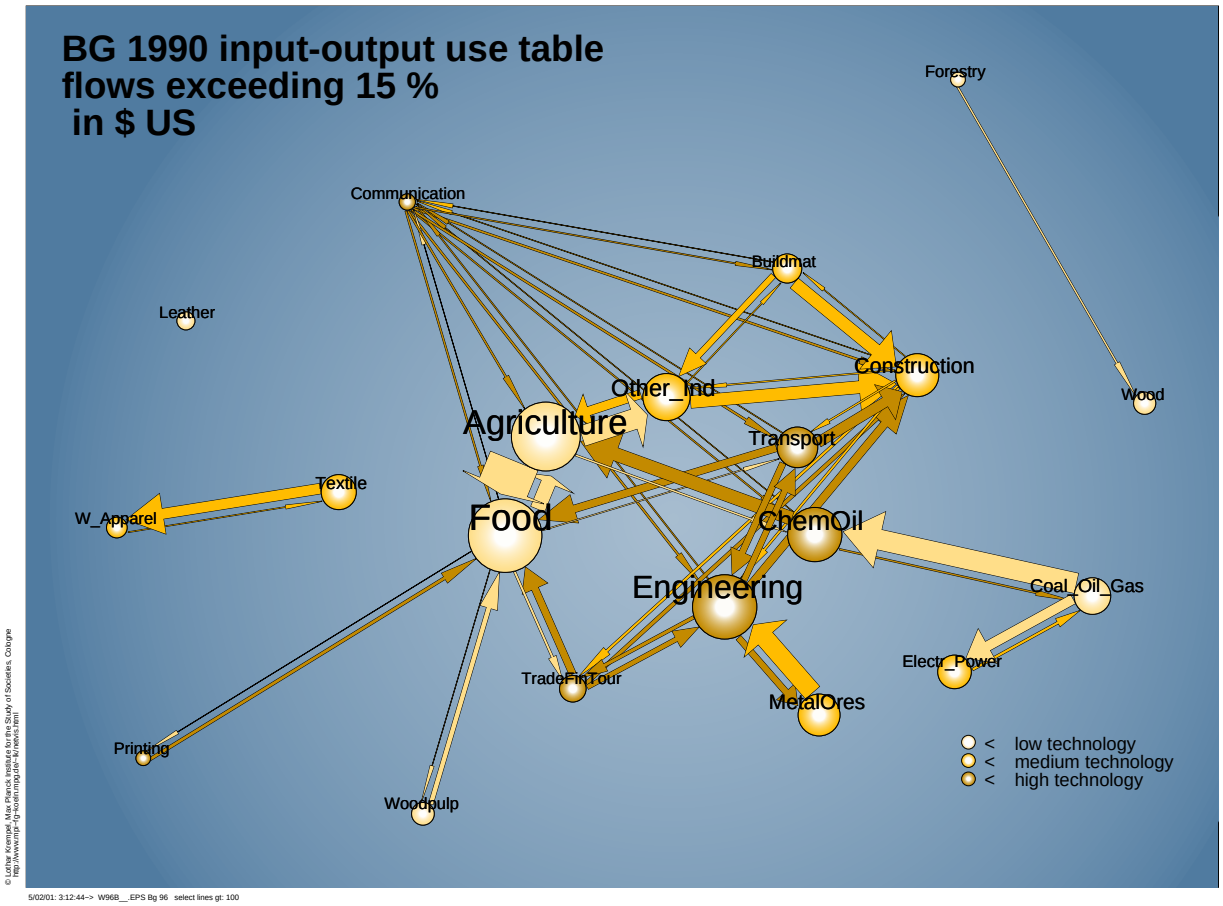

Figure 1: The Bulgarian Economy in 1990,
in the last year of the command economy period, when both national central planning institutions and COMECON were still functioning.

like gross substitutability. If we assume that these equilibrium convergence conditions are met, we can view the equilibrium as a balance between attractive and repulsive forces. The drawing forces can be associated with the inter sectoral exchange. The more intensive the exchange among sectors, the stronger the attractive coercion amid them. Since the trade between sectors is associated with attraction, the gross substitutability and the Walras' Law are the natural candidates for representation of the repulsive potential. Contrary to input-output flows, the gross substitutability and Walras' Law can be understood as system characteristics or as homogeneity assumptions, which characterize the elements of the system. More precisely, the system is supposed to react to price increases (decreases) in

any sector by an increase (decrease) of the excess demand in the other sectors, while preserving zero summary excess demand in the economy as a whole.

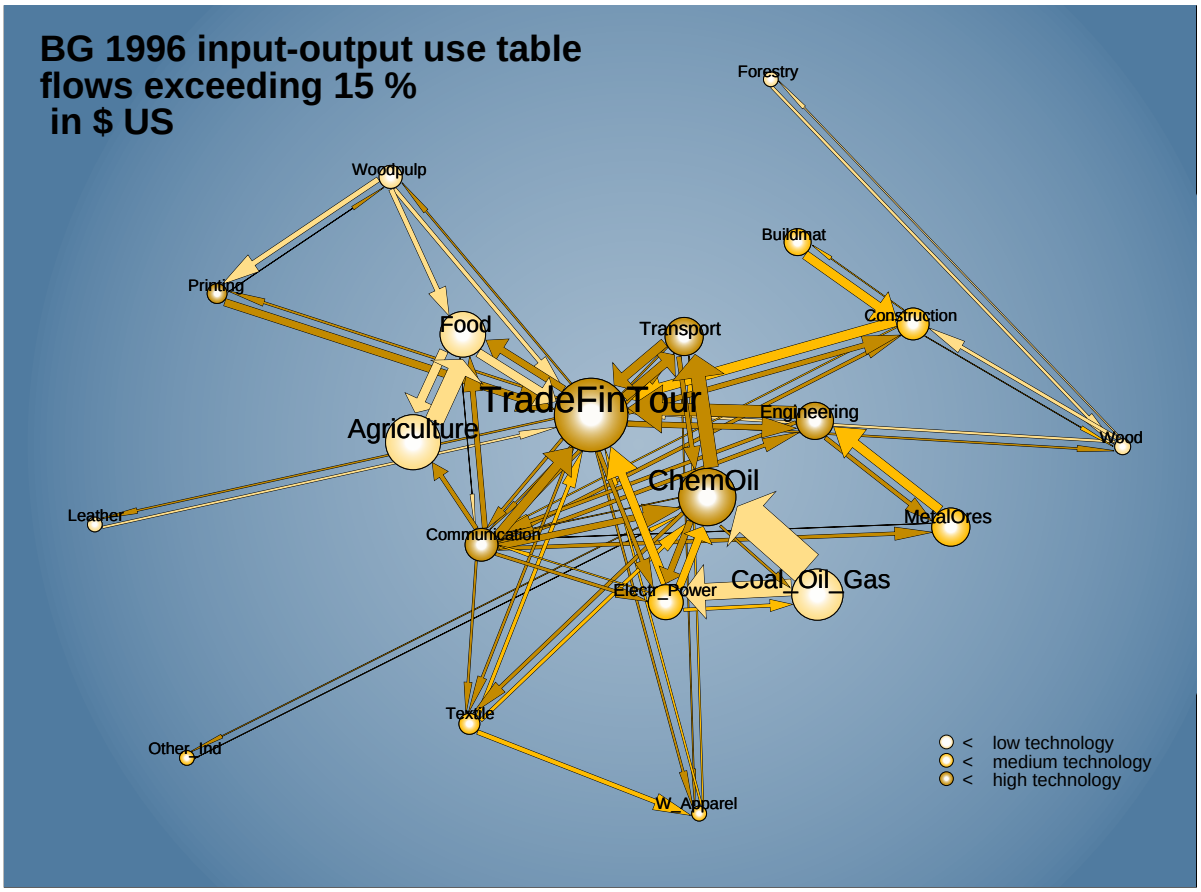

Figure 2: The Bulgarian Economy in 1996
after the shock therapy of 1991 and subsequent market oriented evolution.

Obviously the more important a given sector is as supplier and user, the stronger the repulsive forces in terms of amore intensive summary reaction of the rest of the economy to sector's output price changes. This means that the variations of attractive forces are matched by countervailing alterations of repulsive potential. In equilibrium attractive and repelling forces cancel each other out what corresponds to zero excess demand in economic terms. The key role of the gross substitutability is evident. If the sectors were not gross substitutes but gross complements then any deviation from the equilibrium would generate even higher aberration.

Surprisingly, these general ideas can be visualized. For this purpose we can

use the so called "spring embedders". A visualization technique allowing for computations of equilibrium positions among objects with different attractive and repulsive forces.

The general idea of these procedures is to understand an input-output matrix as a valued graph in which economic sectors are linked by money flows and to apply graph drawing procedures to produce layouts for the nodes. This locates the sectors of the input-output graph in specific positions of a solution space.

Spring embedders are among various other graph-drawing techniques a very flexible family of algorithms. They treat the flows between sectors as attractive forces which are counterbalanced by repulsive electrical fields of a given size which repulse all nodes from each other. Depending on the size of the repulsive forces the layouts can be finetuned (spread or shrunk) while the neighborhoods are maintained which enhances the overall readability.

The resulting layouts are system equilibria at low levels of potential energy where all attractive and repulsive forces balance. Strongly connected nodes are placed near while weakly connected units are placed distant to each other. Nodes with strong flows to many other sectors move to the center of the system whereas sectors are repulsed to the total systems' periphery when they have few or weak links only.

These layouts are often surprisingly easily to read, and can be optimized so that the spacing of the nodes permit communication of additional information about the flows and the sizes of the nodes. Enhanced images allow one to read the position of a given sector in the overall structure of exchange and supply the viewer with additional information: the volume of sectoral transactions are communicated by using arrows of different size and the size of the node symbols of a sector represent the total of all flows a sector is involved in.

Such drawings can be further enriched if additional external data (attributes) are available for the system. In such a case it is possible to map this external information with colorschemes onto the layout. This can help to identify local concentrations of such attributes for specific positions.

If we assume, that to any effective economic equilibrium state corresponds to a computed space equilibrium, then we can regard the visual representations of the latter as isomorphic images of the former. Since the equilibrium of the underlying economy is assumed by definition, the visualization is a "neoclassical" one.The results of the application of spring embedding procedure to the input-output data of Bulgarian economy are presented at Figure 1 and 2.

Figure 1 first is based on 1990 data, the last year of command economy period when both national central planning institutions and COMECON were still functioning. The second makes use of 1996 figures, after the shock therapy of 1991 and subsequent market oriented evolution.

Inasmuch as our aim is to feature the transition shifts, it would be appropriate

to start with sectors that enter or leave the domain with the strongest attractive forces (intensive input-output exchange). Sectors that are repulsed to the periphery are first of all the so called other industries, as well as the wearing-apparel industry. The possible explanation is the increased foreign competition, general economic decline and the less intensive use of inputs from the textile sector in the case of clothing.

On the other hand, we have two opposite examples - communications and printing. Both industries were repelled by the command structures, but integrated by the market forces. The latter happened because of the high importance of branches, involved in information diffusion in a decentralized exchange economy.

There are also relatively stable configurations, like the connection construction-building materials industry or the group of the heavy industries- extraction of coal, oil, gas and metal ores, metallurgy, chemicals, electricity and engineering. The volume and the connections of transportation also remained virtually unchanged. However even within these relatively rigid arrangements we observe important internal changes- the role of oil & gas as well as of chemicals increased, whereas, the importance of engineering declined.

Yet, the most important mutation occurred in the tertiary sector. As we can notice by comparing the Figures 1 and 2, the volume, the connections and the positioning of the aggregated sector of trade, finance and tourism, transformed dramatically. From a business, which was repelled by the command regime to the economic periphery, the sector supplying exchange-related services became central to the economy. Excluding the primary sectors like coal, oil, gas and ores extraction, all the other branches are in fact integrated by the commerce and finance activities. The increase of the value of services' sector supplies and inputs is not as spectacular as the change of its' position in the economy. It clearly plays the role of the organizing center.

This is in striking contrast with the central planning picture, where no such central sector exists. This unexpected feature illustrates the fact, that the planning center (State Planning Committee) of the command economy period was not an economic sector, participating in the exchange, but a political institution of the ruling party. Thus its' directives were in a sense external shocks to the economy. Contrary to command economy, the co-ordination in a decentralized market economy, including state regulation, is carried out through agents and sectors, that participate in the exchange, like commercial banks, trade intermediaries, government purchases, capital market agents, central banks etc.

Finally we can make the conclusion, that the main difference between the command and market economy is that the former is outwardly (politically) integrated while the latter is integrated by different forms of exchange intermediation.

This brief analysis demonstrates, that even if we do not apply any new theoretical assumptions and do not use any new information, the application of vi-

sualization makes generalizations about complex social transformations possible. These changes a are not so obvious and indeed hard to detect without visualization techniques.