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PRODUCTIVITY GROWTH EFFECTS ON OUTPUT AND WELFARE IN UZBEKISTAN: A GENERAL EQUILIBRIUM ANALYSIS

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ABSTRACT

This empirical study describes the results of the This paper using the Social Accounting Matrix (SAM) and computable general equilibrium model (CGE) for Uzbekistan economy presents support for the claim that the progress in the total factor productivity, including progress due to the structural liberalization processes, increases welfare. Input-output table data for the year 2003 from the State Statistical Agency of the Republic of Uzbekistan were aggregated into 5 economy sectors and SAM was constructed to estimate the effects of the shocks in productivity on key macroeconomic aggregates.

A key finding is that nevertheless several other macroeconomic variables are found to be not as robust as welfare indicators for the Uzbekistan, the productivity growth for any one or all Uzbekistan industries is found to increase welfare. However, results indicate that the output growth in response to progress in productivity is not consistently positive if productivity growth rates are low. Another key finding from obtained estimations for Uzbekistan suggests that simulation of productivity growth at the sector with the lowest TFP level, which is agriculture sector for Uzbekistan, stimulates the largest increase in total welfare. This result holds under different scenarios. Therefore, enhancement of policy for development of product markets competition, enterprise, trade and financial reforms in the agriculture sector should be of primarily focus.

Introduction

The general message in the standard or human capital augmented Solow model is that the growth of output per worker on the balanced growth path is equal to the rate of technological progress or the growth rate of labor-augmenting productivity. Significant reform in order to increase productivity growth has been the subject of great debate on how economies can achieve their full potential in terms of employment and productivity growth. Many empirical studies have analyzed the effects of productivity growth and structural reforms on economic growth. Nicolletti and Scarpetta (2003) empirical results using a panel analysis study for developed European countries suggest acceleration in productivity growth from further gradual (over ten year) decrease of the average share of state-owned firms in total value added, with boost of Total Factor Productivity (TFP) productivity growth by 0.7 percentage points. Another study for 20 OECD countries by Saldago (2002) found liberalization reforms implemented during 1985-1995 increased TFP growth by 0.2 to 0.3 percentage points on average. Bayoumi, Laxton and Pesenti (2004) provide a DSGE model-based quantitative assessment of macroeconomic adjustments paths and welfare-based measures of the significant and positive impact of reforms in the product markets on output that is well above 10 percent. Other models results show that welfare-enhancing reforms reap less benefit for more advanced countries with already high level of per-capita GDP (Hunt, 2004; Luna, Lutz and Stavrev, 2005).

Previous research on growth in transition economies reveals that the output growth in recent years was the result not only of the recovery of lost output and progress in macroeconomic stabilization, but also of increase in total productivity. Loukoianova and Unigovskaya (2004) found that productivity gains mattered for growth and growth in TFP for the years 1997, 1998, 1999 was equal to 3.1%, 3.4%, and 4.1% for Uzbekistan. For CIS group of seven low-income Commonwealth of Independent States (CIS) countries (Armenia, Azerbaijan, Georgia, Kyrgyz Republic, Moldova, Tajikistan, and Uzbekistan) TFP growth was 4.6% annually. This is roughly in congruence with the other empirically found values. For example, the Czech Ministry of Finance (2006) for instance found the growth in TFP between 1-3 % during the period 1995-2005 for Check Republic.

Finally, previous research on Uzbekistan economy, to my current knowledge, was mainly focused on policies to boost potential output, or macroeconomic stability, but not on

welfare-enhancing structural reforms to induce growth in real wages, welfare and consumption. In overall, among studies synchronizing reforms in transition economy of Uzbekistan, only policies to stabilize economy or reform foreign and financial markets to avoid a decline in output and export growth rate, were considered previously in different macromodels for Uzbekistan economy and none of them considered effects on welfare.

Outstanding point of this paper is that it constructs the Social Accounting Matrix (SAM) and computable general equilibrium model (CGE) for the Republic of Uzbekistan to examine the relationship between the progress in the TFP (including progress due to the structural liberalization processes) and increases in welfare.

A Computable General Equilibrium (CGE) then was used to estimate the results of simulations of productivity growth. Model calibration (as summarized in Table 2) estimated on the base of SAM for the year 2003 assumed the capital share parameter in production function to be high in sectors of agriculture (0.79), energy industry (0.70) and light manufacturing (0.609), whereas beta share of capital for heavy manufacturing (0.414) and services (0.458) is lower.

Simulations provide effects of growth in the total factor productivity at various growth rates on the increase in: utility levels, percentage changes in output, export, import, and saving in different sectors, and at different scenarios.

Scales of growth rates of total productivity level for all sectors at 1%, 2.2%, 3.8% for possible annual growth rates, at 10%, 20% for possible 5-year accumulated growth rates, and at 40%, 100% for roughly decadal growth rates were set as productivity shocks. Another important simulation used is increase in productivity by the same amount for specific industries of interest: heavy and light manufacturing and agriculture.

Data and Methodology

Empirical CGE modeling requires to estimate various coefficients and exogenous variables of parameters for the utility function and the factor endowments in the model using real data. Empirical estimation of CGE model for Uzbekistan is conducted in two steps. First, I collected data for the 2003 (base) year and compiled a comprehensive and consistent macroeconomic database, or social accounting matrix (SAM). Next, I used the SAM for Uzbekistan to estimate coefficients and exogenous variables for the base 2003 year using

calibration method. Next section illustrates the structure and development of a SAM, the other section shows the calibration procedures.

Structure of Social Accounting Matrix

The SAM constructed on the base of the most recent Uzbekistan input-output matrix compiled for 2003, is shown in Table 1. This SAM, where for the more realistic analysis intermediate input, government (including government consumption, direct taxes, production taxes, import tariffs), investment and saving, as well as transactions of commodities with foreign countries (in short, exports and imports) are used, is used for the estimation of a CGE model.

Table 1. Uzbekistan 5 –sector SAM for the year 2003 used for the estimations

	ENG	HMN	LMN	AGR	SRV	CAP	LAB	IDT	TRF	HOH	GOV	INV	EX	Total
ENG	2036500	602161	123478	366685	406042					245714	0	-1791	356005	4134795
HMN	243834	1977806	250649	248063	885221					311788	0	921766	1676093	6515220
LMN	9754	35024	810471	118337	185267					2191043	0	-7772	1032182	4374307
AGR	427	5549	1559241	550731	17693					1572381	211452	28392	49300	3995164
SRV	1024281	781360	904395	196875	-1276971					1045965	1613793	1102126	517157	5908983
CAP	248429	255663	253893	2078875	1393106									4229966
LAB	106036	361933	163068	550691	1647395									2829124
IDT	353663	255238	-194900	-84318	2290399									2620083

TRF	33	14704	2059	26	2691							19513
HOH						4229966	2829124					7059090
GOV	32755	76237	50344	-71132	50951			2620083	19513			2778751
INV										1692198	953505	-602983	2042721
Import	79083	2149545	451608	40330	307189							3027754
Total	4134795	6515220	4374307	3995164	5908983	4229966	2829124	2620083	19513	7059090	2778751	2042721	3027754	

Note: "-" means trade surplus, "+" means trade deficit in cell "INV-EX"

As discussed above, then constructed CGE model was used to analyze economic activities, such as transactions of commodities and factors between agents (household, firms, government, investment, and foreign sector in an economy) and the flow of funds corresponding to their transactions. For this purpose, transactions were categorized to several categories, such as "production activity," "factor," "indirect tax," "final demand," and "foreign sector" (Table 1). Given Uzbekistan economy, "production activity" is subdivided into five sectors: energy (ENG), heavy manufacturing (HMN), light manufacturing (LMN), agriculture (AGR), service (SRV). Data on amount of total collected direct taxes I put into sell "COV" -"HOH" together with the sum of indirect taxes.

When I actually constructed Uzbekistan SAM, I encountered two problems. First, there were missing data on depreciation and I assumed that capital income includes only profits earned by industries. Second, statistical discrepancies between different data sources, such as input-output tables and balance of payment became evident in constructed SAM. Compiled matrix, for formation of which I used input-output table of 2003 revealed the inconsistenly low import tariff rates for all the industries (about 0.5%).

Calibration procedures

Then the CGE model is calibrated to the Uzbekistan's input–output compiled tables by Uzbekistan State Statistical Agency. As Table 2 depicts, Beta share parameter in production function calculated by the formula beta(h,j)=F0(h,j)/sum(k, F0(k,j)) varies by sectors and has different influences at changes of composite factor production dY(j) and changes of gross domestic output dZ(j). The high share of income goes to capital (CAP share) in sectors of agriculture (0.79), energy industry (0.70) and light manufacturing (0.609). Surprisingly, larger share of beta share parameter in production function (LAB share) is at sectors of heavy manufacturing (0.414) and services (0.458). But these capital income shares are calculated on the base of profit data in these five aggregated sectors and, therefore, share of capital for heavy manufacturing (0.586) and services (0.542) are lower comparing to other countries, since compiled Uzbekistan SAM matrix for the year 2003 doesn't encompassed data on the depreciation.

Since no simple way to measure technology growth exists, I assumed an average growth in the total factor productivity of 4% per annum (in 1995-2005) as estimated by Loukoianova and Unigovskaya (2004) for Uzbekistan starting from 1998.

Table 2. Estimated parameters of production function in the Base Run

		ENG	HMN	LMN	AGR	SRV
b scale coefficient		1.841	1.970	1.953	1.671	1.993
beta share parameter in production function	CAP	0.701	0.414	0.609	0.791	0.458
	LAB	0.299	0.586	0.391	0.209	0.542
CAP factor input		248428.5	255663.4	253892.6	2078875.2	1393106.0
LAB factor input		106036.4	361933.4	163068.2	550691.0	1647395.0

Since change in domestic savings is proportional to change in income, calculation of changes in private household savings and government savings I use given in the initial period the average propensity for private saving (ssp) equal to 0.24 and average propensity for gov. saving (ssg) equal to 0.361**.**

They are calculated on the base of the following formulas:

ssp=Sp0/sum(h, FF(h));

ssg=Sg0/(Td0+sum(j, Tz0(j))+sum(j, Tm0(j))),

where Sp0 - initial level of private saving,

Sg0 - initial level of government saving,

FF(h)- factor endowment of the h-th factor,

Td0 - direct tax,

Tz0(j)- production tax,

Tm0(j)- import tariff

Empirical Results

This section presents the results from estimation of the simulations. Simulations provided effects of the increase of productivity at various growth rates of total factor productivity, and at different scenarios on: utility levels, percentage changes in output, export, import, and rates of growth in saving in different sectors.

Estimation of increase in level of productivity of all sectors

First two columns of the table 3 show scales of utility level increase at various growth rates of total productivity level for all sectors. The results reveal the strong proportionality between rise in productivity level and utility level (table 3).

Table 3. Increase in level of productivity of all sectors: utility levels, saving

	Utility level, (mln sum)	Hicksian EV	saving	
			household	government
			change [%]*	
In the Base Run	1,390,432			
Increase by 1.0%	1,424,000	129,446.2	-0.486	-1.213
Increase by 2.2%	1,440,800	194,565.9	-0.495	-1.191

Increase by 3.8%	1,463,300	281,394.2	-0.506	-1.162
Increase by 10%	1,550,500	617,874.2	-0.548	-1.060
Increase by 20%	1,691,100	1,160,642.5	-0.605	-0.920
Increase by 30%	1,831,800	1,703,468.7	-0.653	-0.803
Increase by 40.0%	1,972,400	2,246,340.3	-0.694	-0.704
Increase by 100.0%	2,808,900	5,475,148.4	-1.943	0.341

* for change of foreign saving in % „-" indicates the percentage decrease in the amount of domestic savings.

The last two columns show changes in private household savings and government savings. From the obtained results it is easy to note that with the increase in the levels of productivity and, correspondingly, levels of income under specified levels of propensity to save, higher productivity stimulates relative decrease in acceleration of the government deficit (diminishing rates of decrease of government savings). For example, government saving reduces by 1.2% within 1% increase in TFP, whereas it reduces by 0.7% within 40% increase in TFP, and increases by 0.34% within 100% increase in TFP. In contrast, the rates of decrease of private (household) savings, increase from 0.49% to 0.69% within 40% increase in TFP, to 1.94% within 100% increase in TFP. These results evidence that higher productivity levels enhance the macrostability measured by the government deficit since government investments are crowded out by the household investments.

Nevertheless the utility level increase was the highest for the Agriculture sector for increase of TFP for all sectors (Table 5), at lower levels of increase in productivity (for example, by 1%), changes in agriculture sector output and export volumes are negative (table 4).

Table 4. Effects of increase in level of productivity of all sectors: output, export and import changes [%] in different sectors

	Increase in level of productivity by:							
	1.0%	2.2%	3.8%	10.0%	20%	30%	40.0%	100.0 %
gross domestic output								
ENG	3.61	4.81	6.39	12.57	22.52	32.47	42.42	106.0
HMN	7.26	8.49	10.12	16.47	26.70	36.94	47.17	121.5
LMN	0.37	1.51	3.03	8.92	18.41	27.91	37.41	85.7
AGR	-0.44	0.72	2.27	8.28	17.96	27.65	37.34	89.9
SRV	0.76	1.99	3.64	10.03	20.32	30.62	40.91	105.7
Exports								
ENG	4.67	5.81	7.31	13.14	22.55	31.96	41.38	102.0
HMN	8.92	10.10	11.66	17.72	27.50	37.29	47.08	123.0
LMN	-3.01	-1.98	-0.60	4.75	13.38	22.01	30.65	64.1
AGR	-4.00	-2.94	-1.52	3.96	12.80	21.63	30.47	64.6
SRV	-2.28	-1.15	0.36	6.20	15.63	25.04	34.46	93.1
Imports								
ENG	2.35	3.62	5.32	11.88	22.48	33.08	43.68	111.
HMN	3.50	4.85	6.65	13.62	24.87	36.12	47.38	117.9
LMN	6.41	7.74	9.51	16.39	27.47	38.57	49.67	124.0
AGR	3.34	4.61	6.31	12.88	23.50	34.12	44.75	114.9
SRV	4.53	5.90	7.72	14.79	26.20	37.62	49.05	121.1

The level of total incomes for agriculture decreases for 1% increase of TFP for all sectors by 1%, level of exports also decrease for agriculture until the increase in TFP for all sectors is more than 4%. Thus, though the growth of output could become negative in agriculture with the rise in TFP, the growth rates of welfare for households are always positive for any given rise in TFP for all sectors.

Estimation of increase in level of productivity of all sectors and separately for manufacturing and agriculture

The same increase by 10% in the productivity levels of separate sectors of Uzbek economy gives different outcomes as measured by utility levels changes and percentage change of domestic private and government savings (Table 5). The industry with the lowest level of TFP is agriculture. But it is this sector with the lowest TFP, which is able to give the largest increase in utility levels of households. Results in table 5 "Increase in level of productivity of manufacturing and services: Utility levels, saving" present the evidence that among three sectors used in this simulation of increase of TFP for each of the three sectors (heavy manufacturing, light manufacturing, and agriculture) by the same amount of 10%, utility of agriculture would be equal to 1,465,300 mln sum, comparing to 1,417,400 in heavy manufacturing and 1,418,500 in light manufacturing.

Table 5. Increase in level of productivity of all sectors and separately for manufacturing and agriculture: Utility levels, saving effects

	Utility level, (mln sum)	Hicksian EV	saving	
			household	government
			change [%] *	
In the Base Run	1,390,432			
Increase by 1.0%:	1,424,000	129,446.2	-0.486	-1.213
Increase by 10%:				
In all 5 sectors	1,550,500	617,874.2	-0.548	-1.060
In only 3 sectors	1,433,600	166,634.7	-0.685	-0.267

(HMN, LMN, SRV)				
HMN **	1,417,400	104,047.5	-0.669	-0.180
LMN	1,418,500	108,228.6	-0.258	-1.205
AGR	1,465,300	288,856.9	-0.852	-1.389

* for change of foreign saving in % „-" indicates the percentage decrease in the amount of domestic savings

** for example, to increase by 10% productivity level in heavy manufacturing sector, the following formula was used in GAMS: b("HMN")=b0("HMN")*1.1

The same 10% increase in level of productivity of all sectors and separately for manufacturing sectors and agriculture by 10.0% results also in totally different changes in output, export and import (table 6). Increase of TFP by 10% in only 3 sectors (HMN, LMN, SRV) show negative growth of exports for the light manufacturing (by -0.234%) and agriculture (by -0.88%). Additionally, increase of TFP by 10% in only 3 sectors (HMN, LMN, SRV) show negative growth of output for the light manufacturing (by -5.94%), agriculture (by -9.43%) and services (by -5.85%). These results of decrease in levels of gross domestic output and exports are opposite to positive growth rates of welfare in these three sectors with 10% increase in level of productivity of these three sectors.

Table 6. Effects of increase in level of productivity of all sectors and separately for manufacturing sectors and agriculture by 10.0%: output, export and import changes [%] in separate sectors

	Increase in level of productivity in:				
	All 5 sectors	Only 3 sectors (HMN, LMN, SRV)	HMN *	LMN	AGR
% changes in gross domestic output:					
ENG	12.57	6.243	4.42	2.54	3.45
HMN	16.47	13.827	13.63	5.23	3.34
LMN	8.92	-0.234	-2.49	1.89	7.12

AGR	8.28	-0.880	-2.10	-0.30	6.44
SRV	10.03	1.725	0.97	-0.09	0.74
% changes in exports:					
ENG	13.14	7.03	2.30	2.95	2.291
HMN	17.72	17.32	17.62	6.32	2.945
LMN	4.75	-5.94	-8.92	0.21	8.796
AGR	3.96	-9.43	-9.06	-4.57	15.982
SRV	6.20	-5.85	-5.14	-3.59	-4.176
% changes in imports:					
ENG	11.88	5.31	7.00	2.06	4.855
HMN	13.62	6.05	4.80	2.76	4.241
LMN	16.39	10.18	9.31	4.85	4.264
AGR	12.88	8.71	5.57	4.26	-2.540
SRV	14.79	11.56	8.79	4.28	6.954

* for example, to increase by 10% productivity level in heavy manufacturing sector, the following formula was used in GAMS: b("HMN")=b0("HMN")*1.1

The same conclusions can be made from the results of increase in level of productivity in any one sector by 10%. Growth rates of LMN and AGR are negative (-2.49%, -2.10%, correspondingly) with increase of TFP only in heavy manufacturing. Growth rates of AGR, and SRV are negative (-0.3% and -0.9%) with increase of TFP only in light manufacturing. Additionally, growth rates of exports in LMN, AGR, and SRV are also negative (-8.92%, -9.06%, -5.14% correspondingly) with increase of TFP only in heavy manufacturing; growth rates of exports in AGR, and SRV are negative (-4.57%, -3.59% correspondingly) with increase of TFP only in light manufacturing; growth rates of exports in SRV are negative (-4.17%) with increase of TFP only in agriculture. Thus, the estimation of effects only by the output growth rates can, therefore, lead to different economic policy decisions.

Conclusion

The Total Factor Productivity (TFP) growth effects are found to positively affect welfare increase under simulation for all Uzbekistan industries. Productivity growth at various growth rates boosted utility levels, output, export, import, and decreased saving in different sectors. Different scenarios were implemented: first, I estimated the effects of increase in level of productivity for all sectors simultaneously at the same percentage; secondly, I estimated effects of an increase in the level of productivity separately for heavy and light manufacturing and agriculture.

I verified the technological progress (% change increase varied in simulations) as having a greater and consistently positive impact on welfare rise than on output and export growth for the Uzbekistan. In case of equal increase of TFP for all sectors, the changes of output and export volumes are negative only at agriculture sector at lower levels of increase in productivity (for example, if TFP increases by 1%, in table 4). The results indicate the output decrease in agriculture of 0.44% in response to progress in productivity.

This limited overall impact of slow productivity increase on output levels reflects two offsetting tendencies. First, small technology positive shocks of less than 1.5% due to liberalization or globalization are associated with a reduction in output growth, and technology positive shocks of less than 4.0% are associated with a reduction in export growth for Uzbekistan economy. Second, larger technology positive shocks are associated with a *consistent increase in all macroeconomic variables, including those of output and export growth rates. This results from both globalization and technological changes stimulate increase in the returns on factor inputs used*, therefore, *underscoring the importance of technological progress in addressing rising both welfare and production*.

It is worth to note that in order to support this growth in productivity and from another side, reap the benefits of higher benefits from the same amounts of factor inputs, private savings of households start to decrease at larger speed when growth rates of TFP become robust and significantly higher. From the other side, government savings start to decrease at lower speed, resulting at lower government expenditures and, hence, at lower risk of accumulation of government deficit. Therefore, with the increase in the levels of productivity and, correspondingly, levels of income under specified levels of propensity to save, higher

productivity ensures macrostability, which is measured by the government deficit, thanks to crowding out effect of government investments by the household investments.

Estimated effects of an increase in the level of productivity separately for heavy and light manufacturing and agriculture showed that the same increase by 10% in the productivity levels of separate sectors of Uzbek economy revealed that sector with the lowest level of TFP, which is agriculture, is able to give the largest increase in utility levels for households. However, results obtained (table 6) found decrease in levels of services exports, opposite to positive growth rates of welfare (export growth rates of LMN are -4.17%) with increase of TFP only in agriculture. Another conclusions can be made from the results of increase in level of productivity in any other of two sectors by 10%. Growth rates of LMN and AGR are negative (-2.49%, -2.10%, correspondingly) with increase of TFP only in heavy manufacturing. Growth rates of AGR, and SRV are negative (-0.3% and -0.9%) with increase of TFP only in light manufacturing. Additionally, growth rates of exports in LMN, AGR, and SRV are also negative (-8.92%, -9.06%, -5.14% correspondingly) with increase of TFP only in heavy manufacturing.

Also, increase in level of productivity in only three sectors (HMN, LMN, AGR) by 10% leads to negative growth of output for the light manufacturing (by -0.234%) and agriculture (by -0.88%), for exports for the light manufacturing (by -5.94%), agriculture (by -9.43%) and services (by -5.85%).

Thus, the estimation of effects only by the output growth rates can, therefore, lead to different economic policy decisions. The level of total incomes from export for agriculture decreases with 1% increase of TFP for all five or only three sectors (HMN, LMN, AGR), level of exports also decrease for agriculture until the increase in TFP for all sectors is more than 4%. Thus, though the growth of output could become negative in agriculture with the rise in TFP, the growth rates of welfare for households are always positive for any given rise in TFP for all sectors. But, estimations obtained suggest that simulation of productivity growth at the sector with the lowest TFP level, which is agriculture sector for Uzbekistan, stimulates the largest increase in total welfare. Hence, enhancement of policy for development of product markets competition, enterprise, trade and financial reforms in this sector should be primarily used. This result holds under different scenarios.

Further Research Potential

In order to oil the wheels of productivity growth, thus, transition economies should minimize strict product market regulations, which underlie accumulated technology gap and entry-limiting regulation, especially in agriculture. Therefore, it is valuable to have the estimations of greater competition in domestic product markets, greater trade openness and financial market reform, that change under activation of welfare and technology level enhancing policy.

SAM model is the instrument that easily traces the casual inter-relations between macroeconomic variables, and most important, welfare, that are changed on activation of welfare and technology level enhancing policy. In addition to overall productivity growth rates, assessment of model results can be made based on the results received during the modeling process for the change of the such macroeconomic exogenous variables as exchange rate, taxes (direct and indirect), real wages indexation, investments (private and government), raw cotton production, export volume of main commodities.

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