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巴拉萨-萨缪尔森效应下购买力平价模型在中美汇率应用中的评估

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摘 要:为了评估巴拉萨-萨缪尔森效应下的购买力平价模型,选择人民币和美元作为目标货币.首先在该效应的基本假设下对模型进行了推导,得出了以劳动生产力和贸易品消费权重等经济变量表示的表达式.在获取相关数据后,以2005年作为基年,对人民币实际均衡汇率进行了估算,通过对实际均衡汇率的估算值与真实值的比较,对模型的适用性做出了初步判断.而后,利用简单线性回归的手段对结果进行了更深入的检验和分析,得出了该模型在此特殊情形下不适用的结论.最后进一步指出了模型内生假设、中美居民消费习惯以及政府干涉等可能导致模型不适用的因素.

关键词:实际均衡汇率模型;人民币汇率;修正购买力平价模型

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0 引 言

经济中的实际汇率可以用两种手段获得:通过理论模型估算获得[1-2];由名义汇率计算获得.考虑到现有文献中对人民币汇率高估与否以及高估比例的讨论众说纷纭[3-5],评估巴拉萨-萨缪尔森效应下购买力平价模型(简称为"修正购买力平价模型")在人民币与美元汇率案例中的适用程度是有必要的.

1 模型的推导及对实际均衡汇率的估算

根据购买力平价理论的基本观点,实际汇率被定义为名义利率与两国价格水平之比的乘积,利用巴拉萨-萨缪尔森效应的五条假设,推导出了计算实际汇率(RER)的计算公式:

$$RER=\frac{(\frac{A_{CN-T}}{A_{CN-N}})^{\alpha}}{(\frac{A_{US-T}}{A_{US-N}})^{\beta}}$$

式中:A代表劳动生产率,α、β分别为中美两国非贸易品在所有商品中的所占份额[6-7],A_{CN}、A_{US}分别表示中国和美国的劳动生产率,T、N分别描述贸易品和非贸易品.

通过分析从StatAPEC等权威网站获取的相关数据,笔者对巴拉萨-萨缪尔森效应的基本假设进行验证,且证实了效应里的条件均成立.将相关数据代入公式后,笔者得到了实际汇率的估算值如图1所示.

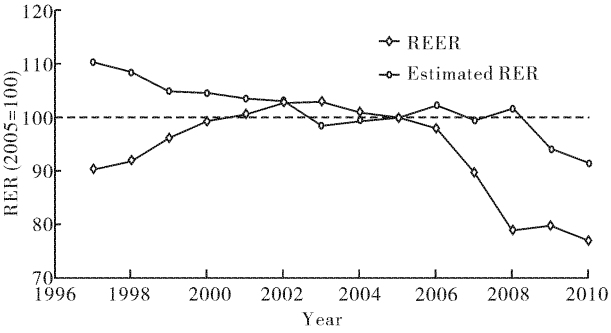

图1 1997年至2010年实际汇率估算值

Fig. 1 Estimated RER from 1997 to 2010

从图1可以看出实际汇率估算值与真实值之间有比较大的差别,说明巴拉萨-萨缪尔森效应下的购买力平价模型在人民币与美元汇率案例应用中可能存在一些问题.

2 修正购买力平价模型的检验

笔者把实际汇率的估算值与真实值进行简单线性回归并得到下列结果(见表1).

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表1 拟合值及检验统计量

Table 1 Fitted values and test statistics

拟合纵截距	拟合斜率	R^2	R^2_{adj}	p 值
80.866 0	0.221 0	0.160 4	0.090 45	0.155 9

从表1可以看出实际汇率的估算值与真实值拟合程度很低，回归非常不显著，并且拟合值与预期的理论值相差甚远. 为了进一步证实这一判断，笔者对中美之间购买力平价数据及名义汇率数据进行比较(见图2)，并利用简单线性回归对估算结果进行分析，发现一价定律在中美货币汇率的案例中并不完全适用.

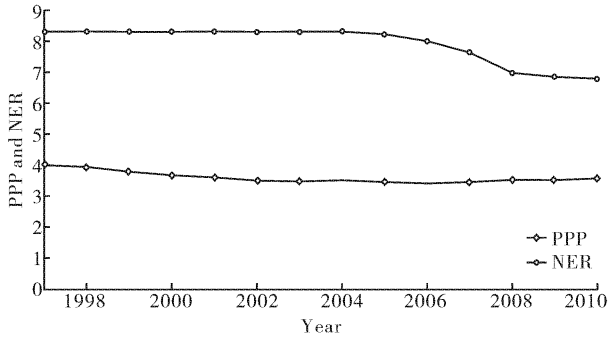

图2 中美之间购买力平价数据及名义汇率数据比较

Fig. 2 PPP and NER from 1997 to 2010

3 结 语

通过分析比较，巴拉萨-萨缪尔森效应下的购买力平价模型在人民币与美元汇率案例中可能主要有下述四点缺陷：贸易品与非贸易品之间没有明确界限；汇率与价格水平之间的影响关系不确定[8]；假设条件忽略了政府在市场中的干涉；中美人民购买的商品品种不具可比性.

参考文献：

[1] ISARD P. Equilibrium exchange rates: assessment methodologies, IMF working paper, WP/07/296[R]. Washington, DC USA: International Monetary Fund, 2007.

[2] BALASSA B. The purchasing-power parity doctrine: A reappraisal[J]. Journal of Political Economy, 1964, 72 (6): 584-596.

[3] COUDERT V, COUHARDE C. Real equilibrium exchange rate in China, CEPII working paper, 2005-1[R]. Paris: Centre d'Étude Prospectives et d'Informations Internationale, 2005.

[4] SATO K, SHIMIZU J, SHRESTHA N, et al. New estimates of the equilibrium exchange rate: the case for the Chinese renminbi[J]. The World Economy, 2012, 35 (4): 419-443.

[5] CHEUNG Yin-Wong, CHINN M D, FUJII E. The overvaluation of Renminbi undervaluation[J]. Journal of International Money and Finance, 2007(26): 762-785.

[6] FARIA J R, LEÓN-LEDESMA M. Testing the Balassa-Samuelson effect: Implications for growth and the PPP [J]. Journal of Macroeconomics, 2003 25(2): 241-253.

[7] FISHER E, PARK J Y. Testing purchasing power parity under the null hypothesis of co-integration [J]. The Economic Journal, 1991, 101 (409): 1476-1484.

[8] DORNBUSCH R. Exchange rates and prices[J]. The American Economic Review, 1987, 77 (1): 93-106.

Assessment of adjusted purchasing power parity model from Balassa-Samuelson effects for China Yuan/U. S. Dollar

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Abstract: To examine the adjusted purchasing power parity model for Balassa-Samuelson effects, we choose China Yuan and U. S. Dollar as target currencies. Based on five assumptions in Balassa-Samuelson effect, we firstly derive a simplified formula for real exchange rate expressed by economics variables such as labor productivity and the expenditure share of non-traded goods. Choosing 2005 as a base year, we estimate the real exchange rate of China Yuan and reach a preliminary diagnostic by comparing estimated values with real equilibrium exchange rates. Simple linear regression method is adopted, and we conclude that this model does not hold in this specific case. In the final part, we point out four drawbacks of this model, which are innate flaws in its assumptions, disagreements in consumption patterns between Chinese and the U. S. citizens, and government interventions, etc.

Key words: real equilibrium exchange rate model; exchange rate of renminbi; revised purchasing power parity method

0 Introduction

In finance, real exchange rate between two specific currencies can be calculated by the nominal exchange rate, and latter is influenced by foreign exchange and the price levels. Also, real exchange rate can be theoretically estimated by mathematical models, namely the four mainstream exchange rate models[1-2]. There will be discrepancies between the actual data and estimated data because models are normally based on simplified assumptions. But there should be one model, whether it is found or not, that is superior to all the others in a specified context.

Among all mainstream models, the purchasing power parity model revised for Balassa-Samuelson effect (revised PPP) is extensively employed to evaluate real exchange rates, especially the rates between Chinese currency, Yuan, and U. S. dollar. But results in papers show enormous disagreements. Most of the research carried out by academia reported an undervaluation of China Yuan. But there exist dissensions in the degree to which CNY is undervalued. In [3], CNY is undervalued by 43%-50%, which deviates from the result of 65% in [4]. But it is argued that there is little statistical evidence that CNY is undervalued in [5].

Actually, whether China Yuan is undervalued is significant, but the reassessment of the applicability of the model is more inspiring. As few scholars have taken this issue into consideration, we decide to investigate the applicability of the model in this paper. Meanwhile, the data used in this paper are collected from 1997 to 2010.

1 Derivation of the Model and Estimation of RER

To begin modeling, it is important to look at the definitions of variables. Two core variables are real exchange rate (RER) and nominal exchange rate (E). Also we take labor productivity (A), wage rate and price level (P) into consideration. Using subscripts CN (for

China), US (for the U. S.), T (for traded sector) and N (for non-traded sector), we distinguish variables considering traded and non-traded variables. We also consider the overall price level in China and the overall price level in the U. S..

Under the revised purchasing power parity model, goods produced in a country can be divided into two separate parts: traded goods and non-traded goods. Traded goods are the goods that can be exported and imported freely. Non-traded commodities are mostly services that cannot be transported between countries.

According to purchasing power parity theory, real exchange rate is the product of nominal exchange rate and the ratio of price levels.

$$RER = E \cdot \frac{P_{CN}}{P_{US}} \tag{1}$$

There are five basic assumptions according to Balassa-Samuelson effect: ①wage rates in both traded and non-traded good sectors are the same; ②differences of labor productivity exist between sectors, and differences in traded sectors are greater than in non-traded sectors; ③the Law of One Price holds in traded sector; ④ perfect competition exists in each sector in each country; ⑤price levels are defined as weighted geometric averages of prices in both sectors, and the geometric weights[6-7] are the expenditure shares on non-traded goods .

Based on above assumptions, after complex and careful computation and derivation, we obtain a simplified RER formula:

$$RER = \frac{(\frac{A_{CN-T}}{A_{CN-N}})^{\alpha}}{(\frac{A_{US-T}}{A_{US-N}})^{\beta}} \tag{2}$$

This formula tells Balassa-Samuelson effect. It shows that if the ratio of traded goods productivity to non-traded goods productivity is growing faster in China than in the U. S. , China should experience an appreciation of the real exchange rate.

Commodities are classified into either traded good sector or non-traded good sector based on their physical forms. According to this classification, we roughly estimate the productivity by calculating real GDP per capita using the data from StatAPEC. We also find that all the assumptions in Balassa-Samuelson effect hold, which means that the conditions for applying this method are well satisfied.

Having had the data from StatAPEC and the World Bank, using the simplified RER formula, the estimated real exchange rate from the revised purchasing power parity model is easily achieved. Here we take a base year of 2005 and set the Estimated RER to be 100 numerically and go on computing the numbers for both the previous and ensuing years. Then the diagram of estimated RER associated with REER is given (Figure 1).

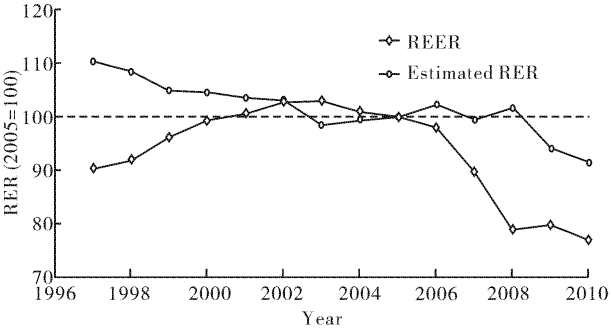

Fig. 1 Estimated RER from 1997 to 2010

From Figure 1, our preliminary diagnostic is that the purchasing power parity model adjusted for Balassa-Samuelson effects doesn't work well, since the two lines don't match closely. There are significant differences in both the early years from 1997 and recent years since 2007.

2 Assessment of Revised PPP Model

The final step is to assess the feasibility of the model mathematically. Conducting a simple linear regression of Estimated RER on REER can give an easier depiction of the result. Regression coefficients and test statistics are shown in Table 1.

Table 1 Fitted values and test statistics

Fitted Intercept	Fitted Slope	R^2	R^2_{adj}	p-value
80.866 0	0.221 0	0.160 4	0.090 45	0.155 9

From the test statistics in Table 1, we conclude that the regression is not significant due to a high p-value. Furthermore, great difference between fitted intercept and the expected

intercept (which is zero) and the significant disparity between fitted slope and the expected slope (which is one) indicate a bad fitted line.

Based on further investigation, it is found that the annual comparative price level data between China and the U. S. associated with average nominal exchange rate, and then we depict the two lines of the purchasing power parity and the nominal exchange rate trends in the same graph (Figure 2).

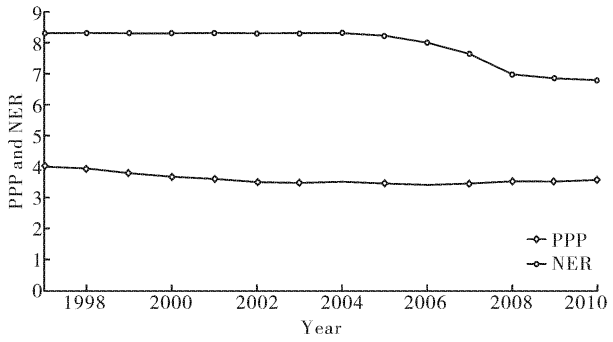

Fig. 2　PPP and NER from 1997 to 2010

According to the Law of One Price, purchasing power parity should be equal to nominal exchange rate in ideal conditions. However, as shown in Figure 2, purchasing power parity is always lower than the nominal exchange rate. While the nominal exchange rate landed after 2005 as a consequence of the exchange rate regime reform by the People's Bank of China, purchasing power parity showed bare variation. So the purchasing power parity theory is not feasible in this CNY-USD case. By the same regression approach for NER on PPP, we find a fitted intercept of 4.356, which largely deviates from the expected slope (which is zero).

3　Conclusion

We combine the results from real equilibrium exchange rate and nominal exchange rate, and therefore conclude that the revised purchasing power parity model does not at all hold for the CNY-USD case. The estimation cannot work well in the revised PPP framework. To complete our conclusion, some disadvantages of this model that may affect our result must be pointed out:

Drawback 1: There is no clear definition for traded goods and non-traded goods. Although both traded goods and non-traded goods have already been defined, there exist a great number of disputes in research field. However, no matter how this classification criterion is set, trade barriers, travel costs, capital movement, tariff speculation, and other factors can never be neglected. In the real world, these factors violate the free flow of goods. The high transportation costs between China and the U. S. and the high tariff of China custom can be considered as crucial factors that influence the applicability of the model.

Drawback 2: The effects of changes in foreign exchange rate are ignored. The purchasing power parity theory asserts that changes in price level induce changes in the foreign exchange rates, but it ignores the fact that the mechanisms may act reversely, i. e. changes in foreign exchange rate also influence the price level, as is illustrated in [8]. People will not be able to make clear of which factor moves ahead of the other and becomes dominant or determining.

Drawback 3: The intervention of governments isn't considered. The purchasing power parity theory only holds in free capital markets, in which the prices of commodities are only determined by supply and demand. However, in the real condition, government will surely exert price control policies to some specific goods, which breaks the auto regulating function of the market.

Drawback 4: The bundles of goods that Chinese people buy and Americans buy are not the same. The mostly extensively consumed goods and services in both countries are not comparable due to the existence of cultural gaps and differences among religions. One example is that Chinese have much stronger preference for the consumption of luxuries while the U. S. citizens spend a greater portion of dispensable income on daily necessities. So it's impossibly hard to choose the bundle of goods that is representative and fair given the different preferences.

In the model that we discuss, assumptions are so idealized that under no circumstance can

they be satisfied in the real world, especially in this Sino-American case. So it makes sense that the purchasing power parity model adjusted for Balassa-Samuelson effects doesn't work for the CNY-USD case in the paper.

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References:

[1] ISARD P. Equilibrium exchange rates: assessment methodologies, IMF working paper, WP/07/296[R]. Washington, DC USA: International Monetary Fund, 2007.

[2] BALASSA B. The purchasing-power parity doctrine: A reappraisal[J]. Journal of Political Economy, 1964, 72 (6): 584-596.

[3] COUDERT V, COUHARDE C. Real equilibrium exchange rate in China, CEPII working paper, 2005-1[R]. Paris: Centre d'Étude Prospectives et d'Informations Internationale, 2005.

[4] SATO K, SHIMIZU J, SHRESTHA N, et al. New estimates of the equilibrium exchange rate: the case for the Chinese renminbi[J]. The World Economy, 2012, 35 (4): 419-443.

[5] CHEUNG Yin-Wong, CHINN M D, FUJII E. The overvaluation of Renminbi undervaluation[J]. Journal of International Money and Finance, 2007 (26): 762-785.

[6] FARIA J R, LEÓN-LEDESMA M. Testing the Balassa-Samuelson effect: Implications for growth and the PPP [J]. Journal of Macroeconomics, 2003 25(2): 241-253.

[7] FISHER E, PARK J Y. Testing purchasing power parity under the null hypothesis of co-integration [J]. The Economic Journal, 1991, 101 (409): 1476-1484.

[8] DORNBUSCH R. Exchange rates and prices[J]. The American Economic Review, 1987, 77 (1): 93-106.

Appendix A: Derivation of Formulae

There are five basic underlying assumptions considering the definition:

1. Wage rate in both traded and non-traded goods sectors are the same:

$W_{CN-T}=W_{CN-N}=W_{CN}$,

$W_{US-T}=W_{US-N}=W_{US}$

2. Difference of labor productivity exists between sectors:

$A_{US-T}>A_{CN-T}$, $A_{US-N}>A_{CN-N}$

and difference between traded sector is greater than non-traded sector:

$$\frac{A_{US-T}}{A_{CN-T}}>\frac{A_{US-N}}{A_{CN-N}}$$

3. The Law of One Price holds in traded sector:

$$E=\frac{P_{US-T}}{P_{CN-T}}$$

4. Perfect Competition, i. e., wage rate equals the multiplication of labor productivity and price in each sector in each country:

$W_{CN}=A_{CN-T}\cdot P_{CN-T}=A_{CN-N}\cdot P_{CN-N}$

$W_{US}=A_{US-T}\cdot P_{US-T}=A_{US-N}\cdot P_{US-N}$

5. Price levels are defined as weighted geometric averages of prices in both sectors:

$P_{CN}=[P_{CN-T}]^{1-\alpha}\cdot[P_{CN-N}]^{\alpha}$

$P_{US}=[P_{US-T}]^{1-\beta}\cdot[P_{US-N}]^{\beta}$

where parameters α and β (geometric weights) are the expenditure share on non-traded goods in China and the U. S., respectively.

Thus we derive formula (2) from formula (1) as follows:

$$RER=E\cdot\frac{P_{CN}}{P_{US}}$$

$$\Rightarrow RER=E\cdot\frac{[P_{CN-T}]^{1-\alpha}\cdot[P_{CN-N}]^{\alpha}}{[P_{US-T}]^{1-\beta}\cdot[P_{US-N}]^{\beta}}$$

$$\Rightarrow RER=E\cdot\frac{\frac{W_{CN}}{A_{CN-T}}\cdot(\frac{A_{CN-T}}{A_{CN-N}})^{\alpha}}{\frac{W_{US}}{A_{US-T}}\cdot(\frac{A_{US-T}}{A_{US-N}})^{\beta}}$$

$$\Rightarrow RER=\frac{\frac{W_{US}}{A_{US-T}}}{\frac{W_{CN}}{A_{CN-T}}}\cdot\frac{\frac{W_{CN}}{A_{CN-T}}\cdot(\frac{A_{CU-T}}{A_{CN-N}})^{\alpha}}{\frac{W_{US}}{A_{US-T}}\cdot(\frac{A_{US-T}}{A_{US-N}})^{\beta}}$$

$$\Rightarrow RER=\frac{(\frac{A_{CN-T}}{A_{CN-N}})^{\alpha}}{(\frac{A_{US-T}}{A_{US-N}})^{\beta}}$$

Appendix B：Basic Indicators in China

Indicator	1997	1998	1999	2000	2001	2002	2003
Total Population (in thousands)	1 230 075	1 241 935	1 252 735	1 262 645	1 271 850	1 280 400	1 288 400
Population, Ages 0-14 of total population/%	26.795	26.451 28	26.016 85	25.483 13	24.838 48	24.097 61	23.311 06
GDP, Current USD (in millions)	952 652.7	1 019 459	1 083 278	1 198 475	1 324 807	1 453 828	1 640 959
Labor Force Participation Rate, Total of total population ages 15+/%	78.004 94	77.646 55	77.309 11	76.993 21	76.622 83	76.269 26	75.918 14
Unemployment Rate, Total of total labor force/%	3.1	3.1	3.1	3.1	3.6	4	4.3
Value Added, Agriculture of GDP/%	18.287 14	17.555 98	16.470 22	15.063 01	14.391 75	13.742 73	12.797 34
Value Added, Industry of GDP/%	47.539 03	46.212 18	45.757 55	45.916 65	45.152 45	44.789 82	45.968 95
Value Added, Services of GDP/%	34.173 83	36.231 84	37.772 23	39.020 34	40.455 79	41.467 44	41.23 371
Employment, Agriculture of total employment/%	49.9	49.8	50.1	50	50	50	49.1
Employment, Industry of total employment/%	23.7	23.5	23	22.5	22.3	21.4	21.6
Employment, Services of total employment/%	26.4	26.7	26.9	27.5	27.7	28.6	29.3

Indicator	2004	2005	2006	2007	2008	2009	2010
Total Population (in thousands)	1 296 075	1 303 720	1 311 020	1 317 885	1 324 655	1 331 380	1 337 825
Population, Ages 0-14 of total population/%	22.547 25	21.855 74	21.254 18	20.731 61	20.273 58	19.854 32	19.455 12
GDP, Current USD (in millions)	1 931 644	2 256 903	2 712 951	3 494 056	4 521 827	4 991 256	5 930 529
Labor Force Participation Rate, Total of total population ages 15+/%	75.559 9	75.292 14	75.081 88	74.916 1	74.546 69	74.367 37	74.195 23
Unemployment Rate, Total of total labor force/%	4.2	4.2	4.1	4	4.02*	4.44*	4.1*
Value Added, Agriculture of GDP%	13.393 12	12.123 02	11.113 45	10.769 71	10.731 57	10.333 15	10.095 32
Value Added, Industry of GDP%	46.225 34	47.366 36	47.948 49	47.338 8	47.446 46	46.241 54	46.669 3
Value Added, Services of GDP%	40.381 54	40.510 62	40.938 06	41.891 49	41.821 97	43.425 3	43.235 38
Employment, Agriculture of total employment/%	46.9	44.8	42.6	40.8	39.6	38.1*	36.7*
Employment, Industry of total employment/%	22.5	23.9	25.2	26.8	27.2	27.8*	28.7*
Employment, Services of total employment/%	30.6	31.3	32.2	32.4	33.2	34.1*	34.6*

Note 1：statistical data above comes from StatsAPEC：http://statistics.apec.org/

Note 2：datum with an asterisk comes from China Statistical Yearbook，2012：http://www.stats.gov.cn/tjsj/ndsj/2012/indexeh.htm

Appendix C: Basic Indicators in the U. S.

Indicator	1997	1998	1999	2000	2001	2002	2003
Total Population (in thousands)	272 657	275 854	279 040	282 162.4	284 969	287 625.2	290 107.9
Population, Ages 0-14 of total population/%	21.771 62	21.659 92	21.524 9	21.373 38	21.205 88	21.024 71	20.840 56
GDP, Current USD (in millions)	8 256 500	8 741 000	9 301 000	9 898 800	10 233 900	10 590 200	11 089 300
Labor Force Participation Rate, Total of total population ages 15+/%	66.184 3	66.240 78	66.300 91	66.324 13	65.984 69	65.673 32	65.333 1
Unemployment Rate, Total of total labor force/%	4.9	4.5	4.2	4	4.7	5.8	6
Value Added,Agriculture of GDP/%	1.685 759	1.300 09	1.219 934	1.190 979	1.181 403	1.009 241	1.197 298
Value Added, Industry of GDP/%	25.365 79	24.099 58	24.047	23.440 63	22.295 06	21.797 99	21.568 78
Value Added, Services of GDP/%	72.948 45	74.600 33	74.733 07	75.368 39	76.523 54	77.192 77	77.233 92
Employment, Agriculture of total employment/%	2.7	2.7	2.6	2.6	2.4	2.5	1.7
Employment, Industry of total employment/%	24.2	23.8	23.2	23.1	22.6	21.9	20.8
Employment, Services of total employment/%	73.1	73.5	74.2	74.3	75	75.6	77.5

Indicator	2004	2005	2006	2007	2008	2009	2010
Total Population (in thousands)	292 805.3	295 516.6	298 379.9	301 231.2	304 094	306 771.5	309 349.7
Population, Ages 0-14 of total population/%	20.666 64	20.512 66	20.380 76	20.269 86	20.181 83	20.117 76	20.077 08
GDP, Current USD (in millions)	11 797 800	12 564 300	13 314 500	13 961 800	14 219 300	13 863 600	14 447 100
Labor Force Participation Rate, Total of total population ages 15+/%	65.098 84	65.145 34	65.279 12	65.105 19	65.073 12	64.398 96	63.665 15
Unemployment Rate, Total of total labor force/%	5.5	5.1	4.6	4.6	5.8	9.3	9.6
Value Added, Agriculture of GDP/%	1.345 075	1.212 484	1.042 895	1.130 17	1.220 378	1.103 414	1.180 634
Value Added, Industry of GDP/%	22.039 38	22.185 55	22.240 89	21.986 73	21.132 57	19.614 27	19.995 69
Value Added, Services of GDP/%	76.615 55	76.601 97	76.716 21	76.883 1	77.647 05	79.282 32	78.823 68
Employment, Agriculture of total employment/%	1.6	1.6	1.5	1.4	1.5	1.5	1.6
Employment, Industry of total employment/%	20.8	20.6	20.8	20.6	19.9	17.6	17.2
Employment, Services of total employment/%	77.6	77.8		78	78.6	80.9	81.2

Note: Statistical data above comes from StatsAPEC: http://statistics.apec.org/

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