Isotope	Medical Use	Half-life	Typical Production
Tc-99m	SPECT	6-hr	Reactor
I-123	SPECT	13.2 hr	Cyclotron
Ga-67	SPECT	78.3 hr	Cyclotron
Th-201	SPECT	73.1 hr	Cyclotron
In-111	SPECT	2.8 d	Cyclotron
Xe-127	SPECT	36 d	Cyclotron
Co-57	SPECT	272 d	Cyclotron
C-11	PET	20 min	Cyclotron
N-13	PET	10 min	Cyclotron
O-15	PET	2 min	Cyclotron
F-18	PET	110 min	Cyclotron
Ga-68	PET	68 min	Ge-68 via cyclotron
Ru-82	PET	1.3 min	Sr-82 via cyclotron
P-32	Cystic Brain Tumors	14 d	Reactor
Sr-89	Metastatic Bone Cancer	50 d	Reactor
Y-90	Liver Cancer	2.7 d	Reactor
Pd-103	Prostate Cancer	17 d	Cyclotron
I-125	Prostate Cancer	60 d	Reactor
I-131	Thyroid Disease/Cancer	8 d	Reactor
Sm-153	Metastatic Bone Cancer	1.9 d	Reactor
Re-186	Metastatic Bone Cancer	3.7 d	Reactor
Re-188	Metastatic Bone Cancer	17 h	Reactor
Ir-192	High Dose Rate Brachytherapy (Breast, Head, Neck, Lung Cancer)	74 d	Reactor

*SPECT – Single Photon Emission Computed Tomography

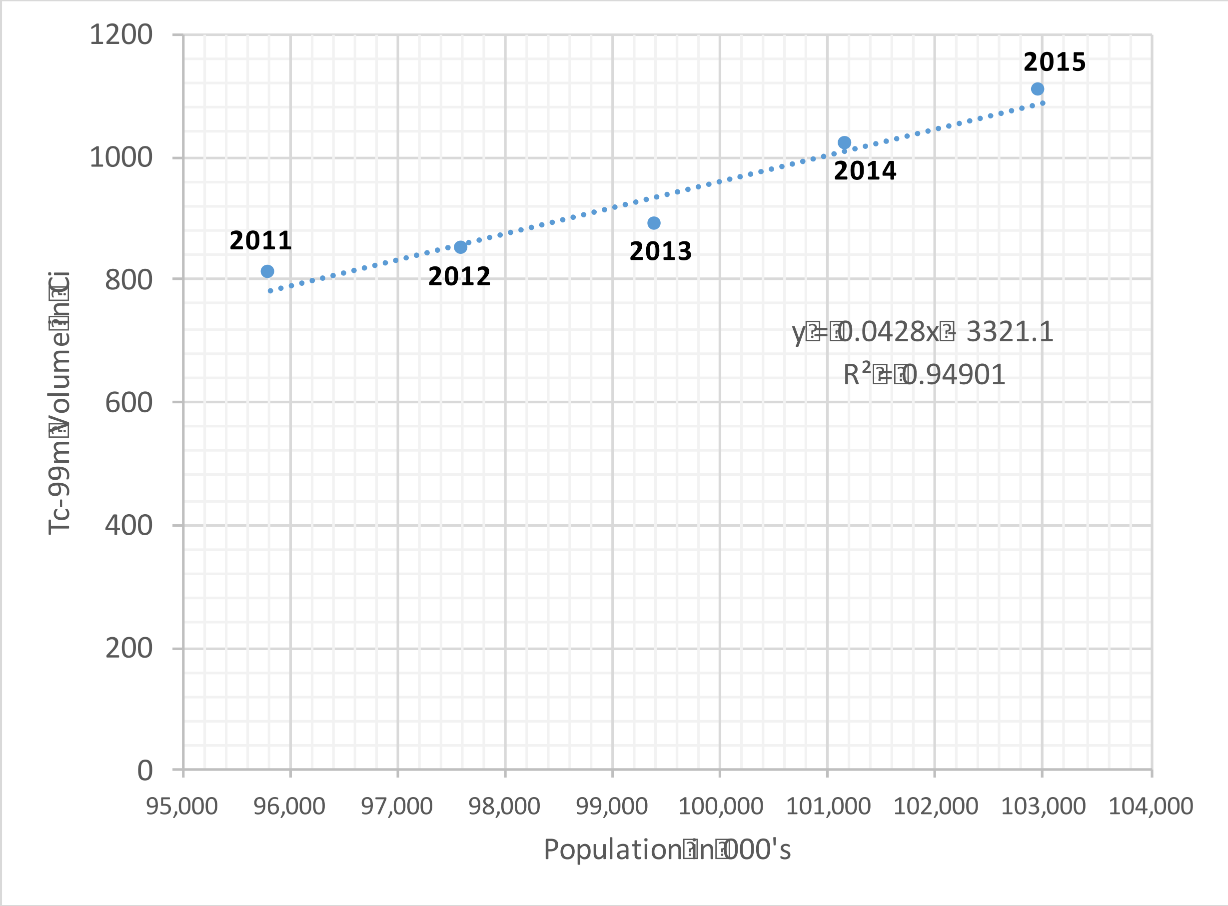
Isotope	Activity per Procedure	Maximum US Treatments per year	Maximum US Demand (Ci)	Demand in a 10^8 person country (Ci)	Annual production in a 10^{14} n/cm^2/sec flux (Ci)	Annual production in a 500 µA target (Ci)
Mo-99/Tc-99m	15-30 mCi (Tc-99m)	20,000,000	1,500,000 (mo-99)	480,000 (Mo-99)	N/A	35,000 (Tc-99m)
Ir-192	10 Ci	400,000	14,000	4459	300	100
I-131	30-200 mCi	200,000	11,000	3503	3400	500
Re-188	90 mCi	100,000	9,000	3,000	N/A	1,000
Sm-153	70 mCi	100,000	7,000	2,300	8,000	100
Re-186	40 mCi	100,000	4,000	1,300	7,000	2,100
Y-90	140 mCi	10,000	1,300	414	7,000	2,800
I-125	50 mCi	10,000	500	170	1600	122
Sr-89	4 mCi	100,000	400	130	400	N/A
P-32	0.5 mCi	<10,000	<5	<3	15	1800

	Potential market share	Dedicated machines needed	Mo-100 needed (kg/year)	HEU that could be produced by required enrichment facilities (kg/year)*
Linac (enriched)	100%	34	2.72	0.5
Linac (natural)	100%	354	0	0
Dedicated Cyclotron	50%	91	43.4	8.2
Multipurpose Cyclotron	25%	0	27.4	5.1
Typical Power Reactor (1000 Mwe PWR)	N/A	N/A	0	500

Tc-99

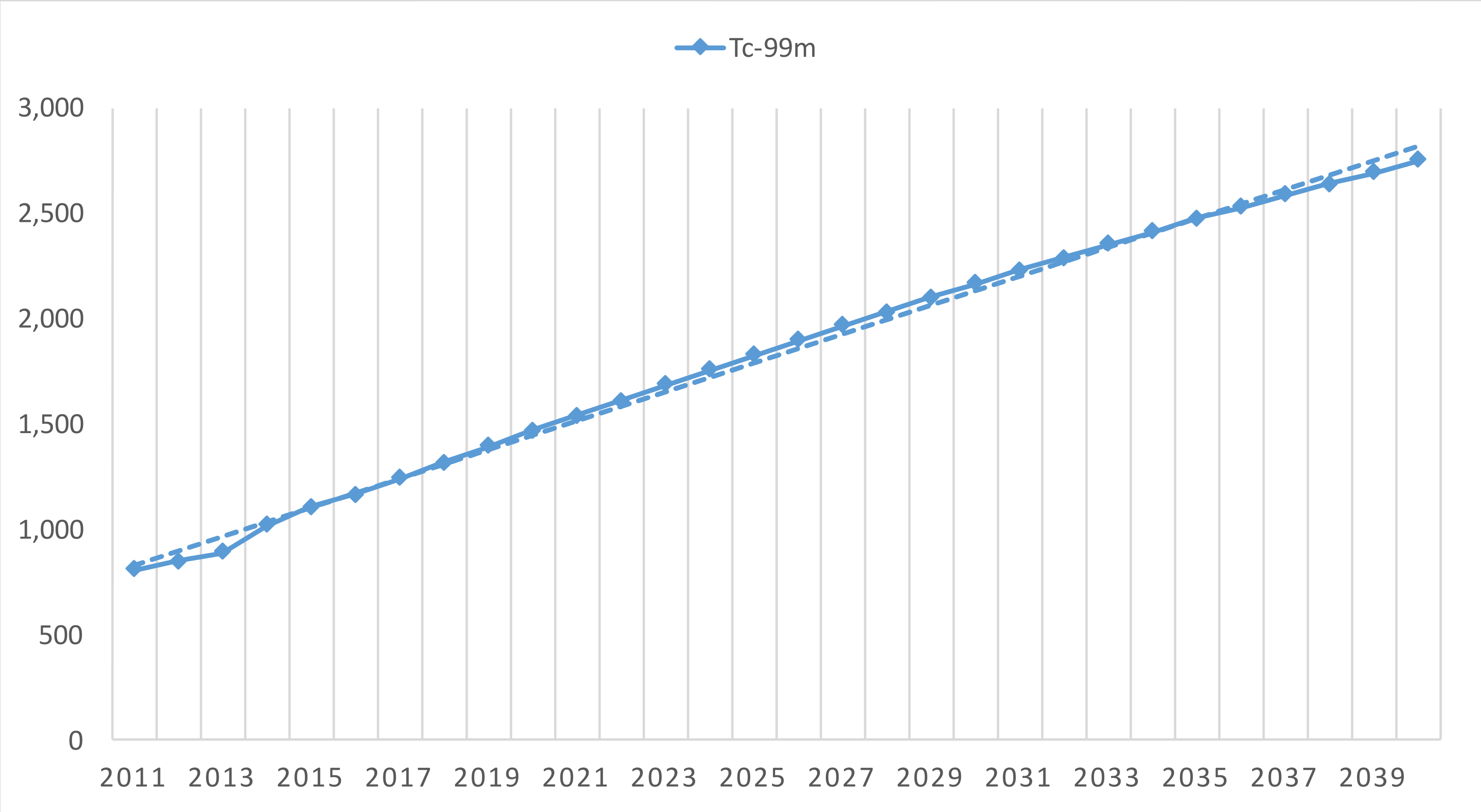
Demand and Outlook

Scatter Plot Diagram for Tc-99m (Dependent Var) and Population (Independent Var)



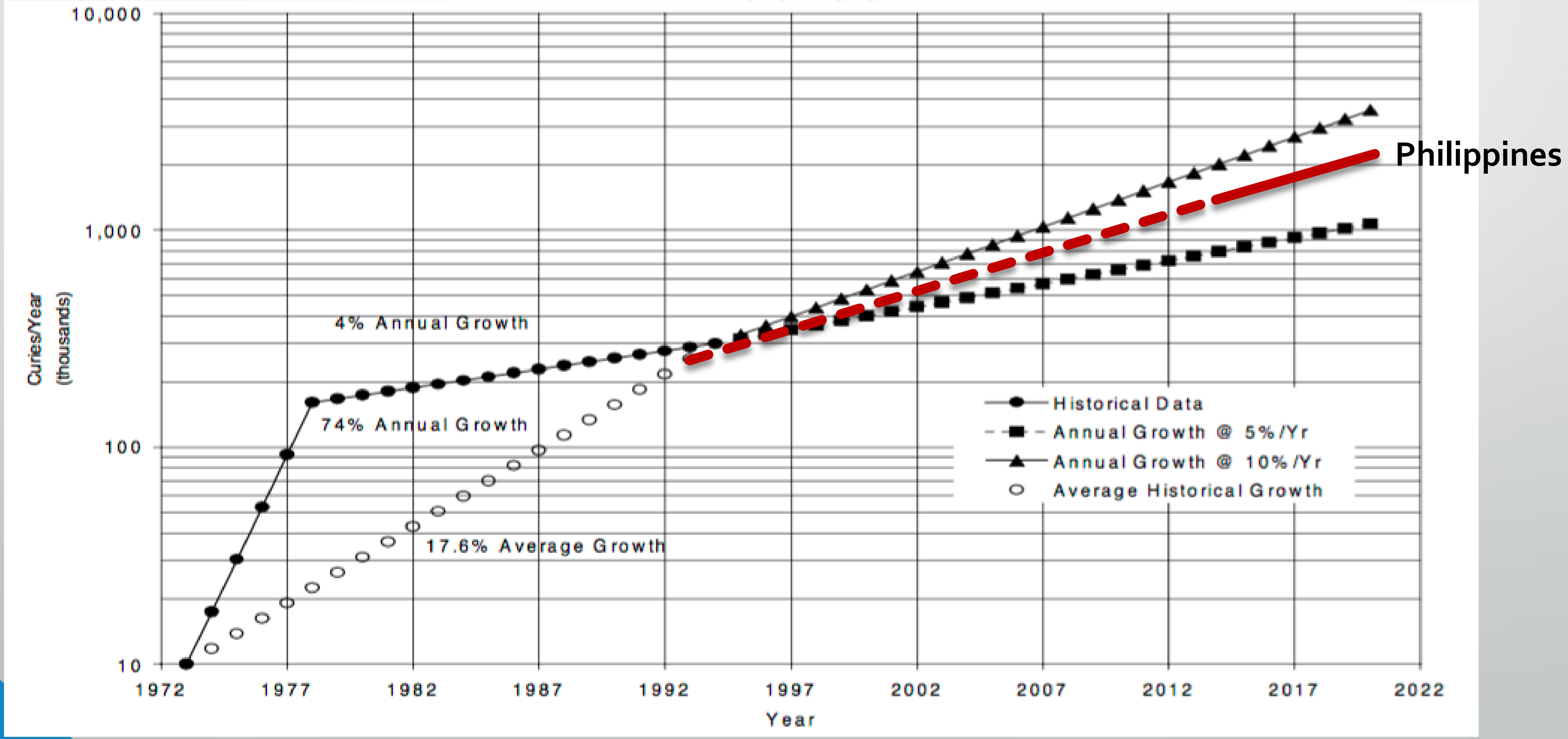
The value of the R^2 represents the good fit of the regression line representing the relationship between population and demand for Tc-99m

Tc-99m Historical Demand and Outlook



The demand for Tc-99m increases 0.0428x for every unit increase in the population

^{99}Mo Historical Demand and Outlook in the U.S.



Y-90

Demand and Outlook

DFG Deutsche Forschungsgemeinschaft

German Center for Research and Innovation – New York

Germany Land of Ideas

The German Center for Research and Innovation and the German Research Foundation cordially invite you to a Leibniz Lecture on

Liver Diseases – A 21st Century Global Health Challenge

Tuesday, May 10, 2016

from 6:30 p.m. to 8:30 p.m.

with

Prof. Dr. Lars Zender

2014 Leibniz Prize Recipient

Gastroenterologist & Oncologist, University Hospital Tübingen

German House, 871 United Nations Plaza (First Ave. at 49th Street), New York, NY

RSVP by May 6 by clicking here. Registration is required to attend. Seating is limited.

Prof. Dr. Lars Zender

2014 Leibniz Prize Recipient

Gastroenterologist & Oncologist, University Hospital Tübingen

German House, 871 United Nations Plaza (First Ave. at 49th Street), New York, NY

RSVP by May 6 by clicking here. Registration is required to attend. Seating is limited.

Reception to follow.

Experts predict that cases of liver disease will double by 2025, resulting in 25 million Americans suffering from chronic liver failure and liver cirrhosis. Chronic liver failure can be treated by liver transplantation, however, the number of donor organs is limited and more than 1.5 million people worldwide are dying of liver failure each year. Liver disease is further complicated by the fact that liver cirrhosis represents the most important risk factor for the development of liver cancer or hepatocellular carcinoma (HCC). HCC is a highly aggressive cancer, which makes it the second most common cause of cancer deaths worldwide. You are invited to join us on May 10, 2016, to learn about a new technology that identifies therapeutic targets for the treatment of liver failure and liver cancer developed by the award-winning Prof. Dr. Lars Zender. He will discuss the role of academic drug discovery infrastructures for rapidly translating validated therapeutic target structures into clinical applications. Zender will show an example of a novel and promising drug for the treatment of liver cancer, which entered clinical trials only 13 months after completion of preclinical testing.

Speaker Biography:

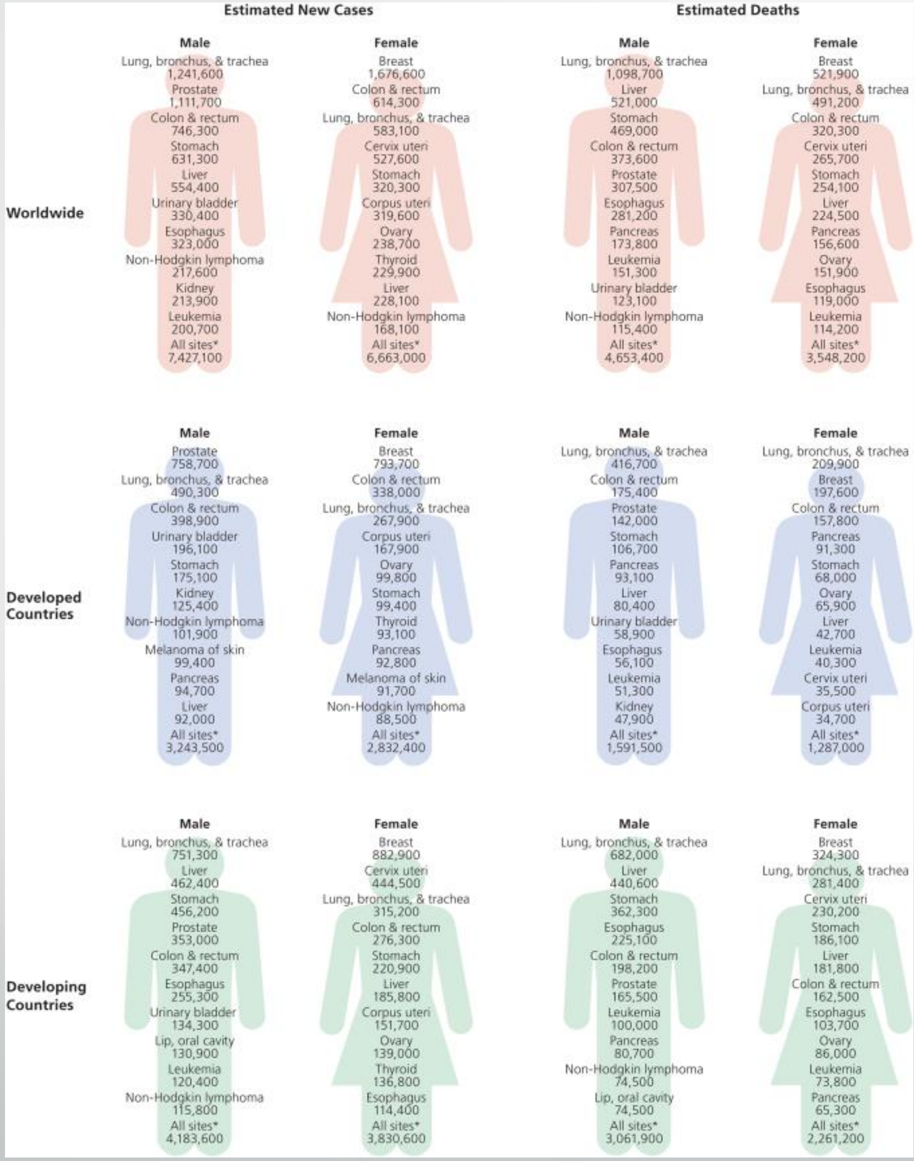
Prof. Dr. Lars Zender was the youngest Leibniz Prize recipient in 2014. The focus of his research is the liver. Zender has decoded fundamental new mechanisms that enable liver function to be maintained or restored. He has developed innovative mouse models which allow RNAi-based functional genetic screens to be conducted directly in vivo and has successfully applied this methodology to identify new therapeutic targets to treat liver failure as well as liver cancer.

The gastroenterologist's and oncologist's second main area of research is the role of senescence (cell aging) in the development of cancer. Zender was able to demonstrate that the "activation" of senescence prevents the formation of tumors from premalignant liver cells and thus represents an important protective mechanism. His work in both fields has generated vital contributions to basic research and new possibilities for the development and improvement of treatment methods.

Born in 1975, Zender began working at Hannover Medical School (MHH) in Germany. During his time there, he became involved in research projects on the regulation of cell death in the liver. After completing his doctorate, receiving his license to practice medicine, and working as an assistant physician at MHH, he joined the laboratory of Dr. Scott Lowe at the renowned Cold Spring Harbor Laboratory in 2004 as a postdoctoral researcher as part of the German Research Foundation's (DFG) Emmy Noether Programme. After returning to Germany in 2008, he continued his work as a leader of an Emmy Noether and an independent Helmholtz junior research group, turning down several invitations from institutions in Germany and abroad. In 2012, he accepted a call to a full professorship at the University of Tübingen, one of the universities recognized by the German Excellence Initiative. Zender works as a

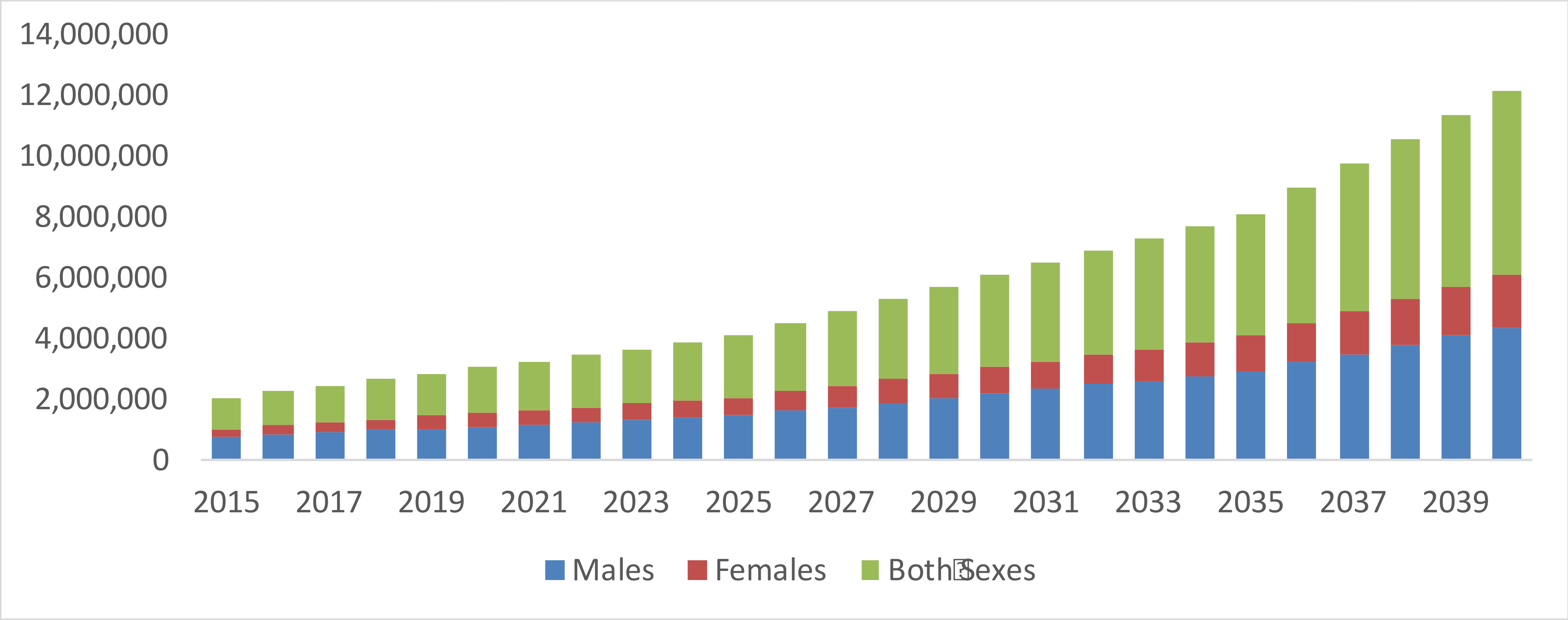
Experts predict that cases of liver disease will double by 2025, resulting in 25 million Americans suffering from chronic liver failure and liver cirrhosis

Global cancer statistics, 2012

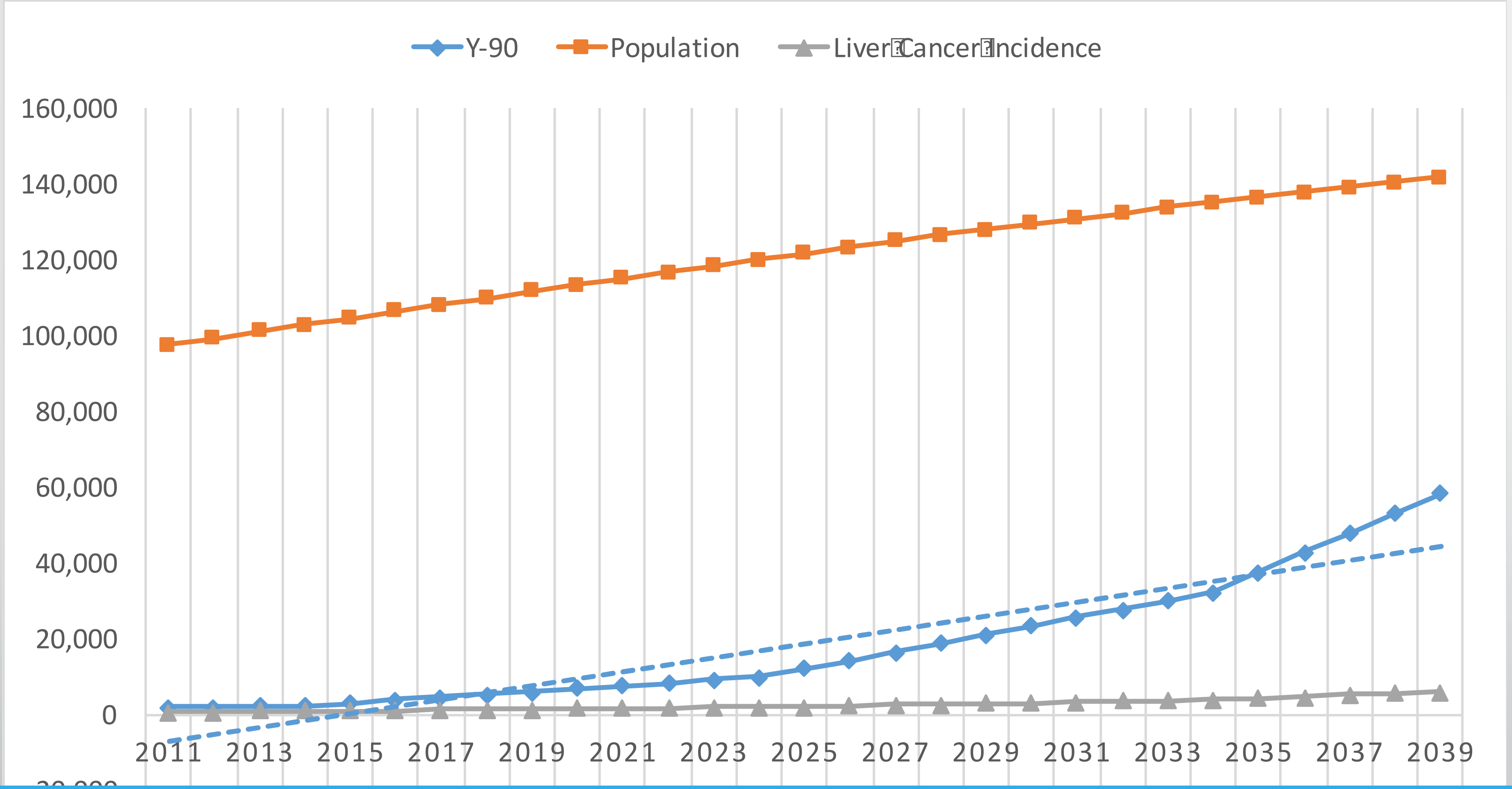


CA: A Cancer Journal for Clinicians
Volume 65, Issue 2, pages 87-108, 4 FEB 2015 DOI: 10.3322/caac.21262
http://onlinelibrary.wiley.com/doi/10.3322/caac.21262/full#caac21262-fig-0002

Liver Cancer Incidence Outlook for the Philippines



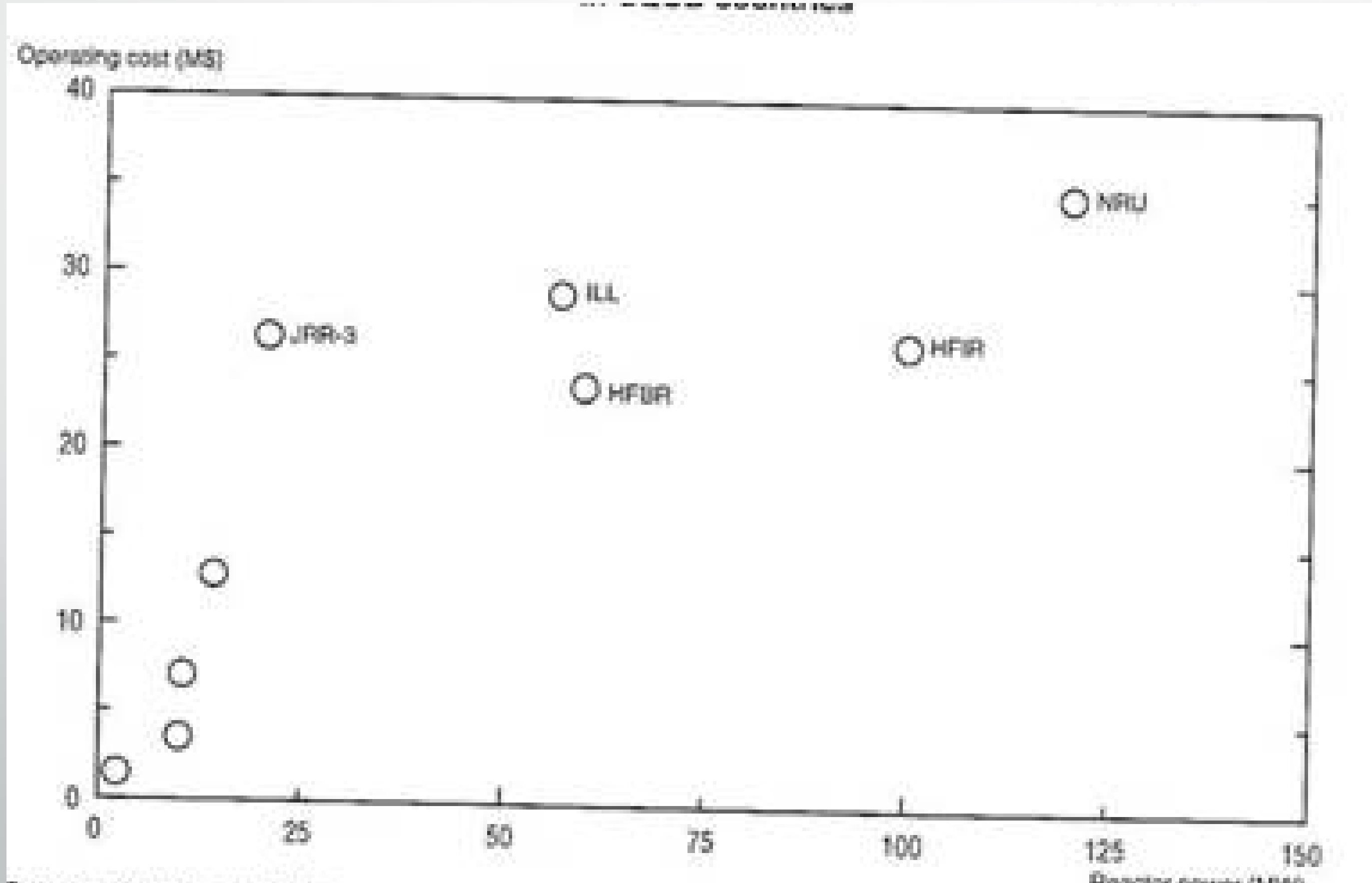
Regression Analysis / Forecast for Y-90



The demand for Yttrium 90 changes for every unit change in the population, or liver cancer incidence. There is visible increase in the Y-90 demand as the liver cancer incidence doubles every 10 years.

Cost

Current Annual Operating Costs of Research Reactors in OECD Countries



Source: Author's estimates

Original Investment Cost for Some of the Research Reactors Commissioned in 1957-71 in OECD Countries